

Turbonomic 8.6.0 Documentation



Chapter 1. Turbonomic 8.6.0 Documentation

- [Release Notes](#)
- [Installation](#)
- [Product Overview](#)
- [Getting Started](#)
- [Target Configuration](#)
- [User Interface Reference](#)
- [API Reference](#)

Chapter 2. Release Notes

July 27, 2022

This document describes issues that are addressed in Turbonomic 8.6.0 – Release Date: July 27, 2022. Please see the Turbonomic 8 documentation for earlier versions of the Release Notes:

<https://docs.turbonomic.com/>

Note:

These release notes are for update to Turbonomic 8.6.0, from version 7.22.0 or later. For updates from the 7.21.x family or earlier, please contact your Technical Support representative.

For any questions, please contact IBM Technical Support at support@turbonomic.com, or open a ticket at:

<https://support-turbonomic.force.com/TurbonomicCustomerCommunity/s/customer-support>

What's New

Turbonomic 8 is powered by our next-generation architecture, allowing the core platform to scale with large application and infrastructure environments in a single-instance deployment. This eliminates complexity and provides scale-on-demand capabilities, while continuing to assure application performance and health.

Version 8.6.0

- **Product Enhancement Requests are now IBM Ideas**

Please submit your Ideas (Product Enhancement Requests) via the IBM Ideas Portal located at <https://ideas.ibm.com>. If you do not already have an IBMid, you will be required to create one. This process is very simple and takes approximately two minutes. Just click **Add a new idea**, fill in the required fields, and type 'Turbonomic ARM' as the product.

Your Idea will be assigned to Product Management and reviewed for possible implementation. By using the Ideas portal, your Idea will be shared with other customers who can then 'Up Vote' it, our Product Management team can reach out with questions, and you will be updated as the status of the Idea changes.

- **On-prem Resource Management**

- **vCPU Scaling Controls for On-prem VMs**

This release introduces vCPU Scaling Controls to help you resize the vCPU capacity of VMs more accurately and enforce compliance with operational policies.

To resize capacity, Turbonomic changes a VM's socket or cores per socket count. When a VM is optimally sized but violates an operational policy, Turbonomic generates a reconfigure action to bring the VM into compliance.

For details, see [vCPU Scaling Controls](#).

- **Utilization Charts for Business User Entities**

For Horizon VDI environments, Turbonomic uses percentile calculations when analyzing the vMem and vCPU utilization of Business User entities. When you set the scope to a Business User, you will now see charts that highlight resource utilization percentiles for a given observation period.

- **Cloud Resource Management**

- **Newly Supported AWS Instances**

This release introduces support for AWS EC2 [C6a instances](#).

- **Support for Azure vCore**

This release introduces support for Azure SQL Databases that are managed under the vCore pricing model. Turbonomic automatically discovers these databases when you add Azure targets. It monitors resource utilization for the databases and uses percentile calculations to generate accurate scaling recommendations.

For details, see [Database \(Cloud\)](#).

- **Uploads to Azure**

For plans that simulate the migration of on-prem VMs to Azure, you can now upload the plan results to the Azure Migrate portal as part of your cloud migration process.

For details, see [Uploading Plan Results to Azure Migrate](#).

- **Instance Store Aware Scaling for Azure VMs**

To ensure cloud scaling actions respect instance store requirements, Turbonomic supports Instance Store Aware Scaling for VM policies. Starting with this release, you can use this setting for Azure workloads.

- **Support for GCP Folders**

Turbonomic now discovers GCP folders when you add a service account target with permissions to retrieve folders.

To see all the discovered folders, go to the Top Accounts chart or use the new 'Folders' category in Search. You can set the scope to a specific folder to see member projects and subfolders, as well as actions and costs for VMs in the projects.

- **GCP Committed Use Discount Coverage**

The Discount Coverage chart now shows the percentage of VMs covered by GCP committed use discounts.

If you have a high percentage of on-demand VMs, you should be able to reduce your costs by increasing coverage. To increase coverage, Turbonomic will recommend scaling VMs to instance types that have existing capacity.

- **Container Platform Management**

- **Constraint for Sidecar Container Specs**

A Kubernetes service might include [sidecar](#) Container Specs to provide additional services to a running pod, such as security or logging services. Sidecars injected at pod creation cannot be updated from the parent Workload Controller, causing a resize action to fail.

To prevent the execution of resize actions on injected sidecars, Turbonomic now adds them to a new group called "Injected Sidecars/All ContainerSpecs". This group applies a read-only policy that sets the action mode for resizes to *Recommend*. This means that you can only execute resizes outside of Turbonomic. The parent Workload Controller will continue to resize non-sidecar Container Specs as usual.

- **Improvements**

- **Entity Filters**

The following filters are now available when you use Search or create groups:

- Target Name, Target Type, and Target Category

These filters return a list of VMs managed by the targets that you specified. *Target Name* supports regular expressions. *Target Type* includes individual hypervisors, cloud providers, container platforms, and APM vendors. *Target Category* includes groups of related targets.

- Instance Type

This filter returns a list of cloud VMs running on the instance types that you specified.

- Days Unattached

This filter returns a list of cloud volumes that have been unattached for a certain number of days.

– Automation Policies

The user interface now displays a confirmation dialog box before you save changes to an automation policy. This reminds you to consider the impact your changes might have on multiple entities in your environment.

– Real-time Analysis

If Turbonomic real-time analysis times out, the actions that the platform generates may be incomplete. When this happens, the platform now restarts the analysis and generates a notification in Notification Center > System Health. The notification goes away as soon as the analysis completes in a succeeding market cycle. If the notification persists for an extended period of time, contact Turbonomic Support for assistance.

The default timeout is 3600 seconds (60 minutes). To use a different value, change the `rtAnalysisTimeoutSecs` property in the `CR.yaml` file.

– Non-executable Actions

This release improves the handling of actions that are currently not executable due to prerequisite actions.

For example, in order to suspend Host A, VM_01 in the host must first move to Host B. However, Host B only has capacity for one VM and is currently hosting VM_02. In this case, Host A suspension is blocked by two prerequisite actions – VM_02 moving to another host and VM_01 moving to Host B.

The Action Details page for the main action (Host A suspension in the example) now shows the following information:

"Blocked by actions on target or destination that need to be executed first."

When all the prerequisite actions have been executed, the main action becomes executable.

– License Management

The License Configuration page now displays a tabular view of your existing licenses to help you better manage these licenses. With this new view, you can sort licenses by status, expiration date, workload count, or type. You can continue to import or delete licenses as usual.

– GCP Error Logging

When discovery of a GCP billing account target fails due to permission-related errors (for example, insufficient or invalid permissions), logs now show the errors to help you troubleshoot the issue.

– ServiceNow Integration

In the ServiceNow user interface, actions to start, provision, or reconfigure entities no longer show information that are not relevant to those actions. For example, a VM reconfigure action no longer shows From and To information, which is only relevant to move and resize actions.

– Active Directory and LDAP Support

You can now configure user accounts to use Active Directory 2019 for authentication. Also, you can use LDAP channel binding and LDAP signing. To support these Active Directory features, you must configure secure access. For more information, see "Enforcing Secure Access" in the *Turbonomic Installation Guide*.

– NetApp Support

Turbonomic now supports ONTAP 9.

To comply with NetApp support for ONTAP, the NetApp target no longer supports NetApp in 7-mode. For more information, please see your NetApp documentation.

Versioning Explanation

Turbonomic versioning uses V-R-M elements (Version, Release, Modification) in the version number to express the status of a given release, as follows:

Numbered Element	Example	Description
V - Version number	8.X.X	<ul style="list-style-type: none"> Changes to platform architecture or significant changes to data models
R - Release number	X.2.X	<ul style="list-style-type: none"> Major feature changes
M - Modification number is zero (0)	X.X.0	<ul style="list-style-type: none"> A quarterly release All preview features from previous bi-weekly releases are now GA No new preview features in this release
M - Modification number is greater than zero (1 or higher)	X.X.3	<ul style="list-style-type: none"> A bi-weekly release Can include new preview features Includes fixed issues

Note:

For API developers, the X.X.1 release can include final implementations of deprecated API features. These final implementations can make API changes that are not backward-compatible.

Note:

Deprecation Notice for Tbmigrate, the Classic-To-XL Migration Tool

Starting with the 8.5.0 release of Turbonomic, we will no longer support the Classic-To-XL Migration Tool. This tool provides a scripted interface that you can use to migrate from Classic installations (the 6.x version families) to XL installations (the 8.x version families).

You can still use this tool to migrate from Classic to the 8.4.x version family. We recommend that you migrate to version 8.4.0, then update to the latest version.

For more information, see "Appendix: Migrating Turbonomic from Classic to XL" in the *Turbonomic Installation Guide*.

Configuration Requirements

For this release of Turbonomic, you should satisfy the following configuration requirements.

Turbonomic Updates and Operator Version

Turbonomic deploys as a cloud-native application on a Kubernetes cluster. This cluster can be pre-configured on a VM that you deploy, or you can deploy Turbonomic to a Kubernetes cluster in your environment. In either case, Turbonomic uses an *Operator* to manage the application deployment.

For different versions of Turbonomic, we change the version of Operator you should use, as follows:

Product Version:	Operator Version:
8.5.7 - 8.6.0	42.12
8.5.6	42.11
8.5.4 - 8.5.5	42.10
8.5.2 - 8.5.3	42.9
8.4.6 - 8.5.1	42.7
8.4.4 - 8.4.5	42.6

Product Version:	Operator Version:
8.4.3	42.5
8.4.1 - 8.4.2	42.4
8.3.5 - 8.4.0	42.3
8.3.4	42.2
8.3.2 - 8.3.3	42.1
8.3.1	42.0
8.3.0	8.2

When you update Turbonomic, you should be sure to always include the matching version of Operator in the update. When you perform an online or offline update according to the instructions in the Installation Guide, the procedure should automatically include the latest Operator.

If you have installed Turbonomic on a Kubernetes cluster, you might need to manually update the Operator version.

OpenShift Installations of Turbonomic

For versions of OpenShift 4.x or later, if you manage your installation via OpenShift OperatorHub, navigate the OPC Console to **Installed Operators**. Select the version of the Turbonomic Operator that you want to use, and click **Update**. This should update the Operator, and you can now update Turbonomic to the matching version.

Other Kubernetes Installations of Turbonomic

For installations on other supported Kubernetes platforms, you can update the Operator version in either one of two ways:

- Directly edit the running deployment of Turbonomic:

1. Enter Edit mode for your cluster.

```
kubectl edit deployment t8c-operator -n {YourNamespace}
```

2. Edit the Operator image.

Find and edit image: {required value}

3. Validate that the Operator pod is ready.

Execute the command: `kubectl get pods -n {YourNamespace}`, and verify that the pod is running and ready.

- Edit the Turbonomic deployment YAML file:

1. Open the Operator deployment file for editing.

In the location where you store your manifests, open the file `operator.yaml`. This should be the file that you use to deploy the `t8c-operator` pod.

2. Edit the Operator image.

Find and edit image: {required value}

3. Apply the change to the operator.

```
kubectl apply -f operator.yaml
```

4. Validate that the Operator pod is ready.

Execute the command: `kubectl get pods -n {YourNamespace}`, and verify that the pod is running and ready.

After you have updated the Operator version, and you have verified that the pod is running and ready, you can edit your Custom Resource declaration to update Turbonomic to the version that matches your Operator version.

For more information, contact your support representative.

Supported MariaDB Version for OVA and VHD Installations

For its default historical database on OVA and VHD installations, Turbonomic currently supports MariaDB version 10.5.16. This support includes comprehensive testing and quality control for Turbonomic usage of the historical database.

Important:

Because of a known issue, *you must never use* MariaDB versions 10.5.14, 10.5.15, 10.6.7, 10.7.3, or 10.8.2.

If you are running Turbonomic installed as an OVA or VHD image, and using the database that is included in that installation, then you must use version 10.5.16. For versions of Turbonomic that you installed as an OVA or VHD *before* version 8.5.6, if you have not explicitly updated MariaDB to 10.5.16, then you must do it now.

For information about updating your MariaDB instance, see "Verifying your MariaDB Version" in the latest version of the *Turbonomic Installation Guide*.

Required Database Capacities

For Turbonomic versions 8.0.6 or later, your historical database must provide certain storage size capacities. For MariaDB or MySQL installations, you must ensure your database provides the necessary messaging and logging capacity.

If you installed Turbonomic as an OVA, and use the included MariaDB for the historic database, the easiest way to set the correct capacities is to update your Turbonomic deployment to the latest version. For more information, see "Increasing your Database Capacities" in the latest version of the *Turbonomic Installation Guide*.

SQL Modes for External Databases

If you deploy Turbonomic to work with an external database instead of the included historical database, then you must specify the correct SQL modes for the database. Configure the database to support:

```
{{ERROR_FOR_DIVISION_BY_ZERO,NO_AUTO_CREATE_USER,NO_ENGINE_SUBSTITUTION}}
```

In particular, the SQL modes should *not* include ONLY_FULL_GROUP_BY, NO_ZERO_IN_DATE, or NO_ZERO_DATE.

External Databases and Turbonomic Updates

If you have deployed Turbonomic with an external database server, for some updates you might need to manually create a new database and user for that deployment. This is important if your external database server is multi-tenant, or if your deployment does not grant administrative privileges to Turbonomic.

Note:

If your external database server is multi-tenant, or if your database server does not grant administrative privileges to Turbonomic, then you must continue with this configuration requirement.

Azure database services are multi-tenant. If you deployed an external database on Azure, this configuration requirement applies to you.

If you deployed your database server in a way that grants Turbonomic privileges to create new databases and new users, then the update will automatically create the required database. This configuration requirement does not apply to you and you do not need to take any action.

For some Turbonomic updates, the updated version includes new databases on the historical database server. If you are updating to one of these versions, then you must *first* create the new database, and a user account with privileges to access that database. After you have done this, you can update to the latest version of Turbonomic.

For more information, see "External DBs and Turbonomic Updates" in the latest version of the *Turbonomic Installation Guide*.

Transport Layer Security Requirements

By default, Turbonomic requires Transport Layer Security (TLS) version 1.2 to establish secure communications with targets. Most targets should have TLS 1.2 enabled. However, some targets might not have TLS enabled, or they might have enabled an earlier version. In that case, you will see handshake errors when Turbonomic tries to connect with the target service. When you go to the Target Configuration view, you will see a Validation Failed status for such targets.

In particular, we have found that NetApp filers often have TLS disabled by default, and that the latest version they support is TLS 1.0. If your NetApp target fails to validate, this is could be the cause.

If target validation fails because of TLS support, you might see validation errors with the following strings:

- No appropriate protocol

To correct this error, ensure that you have enabled the latest version of TLS that your target technology supports. If this does not resolve the issue, please contact Technical Support.

- Certificates does not conform to algorithm constraints

To correct this error, refer to the documentation for your target technology (for example, refer to NetApp documentation) for instructions to generate a certification key with a length of 1024 or greater on your target server. If this does not resolve the issue, please contact IBM Technical Support.

Fixed Issues

- **Fixed Issue:**

Fix Version: 8.6.0

Fix Version: 8.6.1

- **Customer Issue 121054**

For AWS, if analysis discovers a null region string, discovery can fail.

For AWS environments, as Turbonomic discovers entities, if it encounters a null region string, discovery for that target can fail.

- **Fixed Issue:**

Fix Version: 8.6.0

Fix Version: 8.6.1

- **Customer Issue 120870**

For New Relic, if the target experiences a delay in data collection, the user interface can show the target as invalid.

For New Relic, if the target experiences a delay in data collection, the user interface can show the target as invalid.

- **Fixed Issue:**

Fix Version: 8.6.0

Fix Version: 8.6.1

- **Customer Issue 119831**

For very large AppDynamics environments, the user interface can incorrectly show that the target failed to validate.

For a very large AppDynamics environment, target discovery can take a long time, sometimes even hours, to complete. This is expected behavior, and once discovery completes the target operates correctly. However, for a very long discovery cycle the user interface can show the target in red, indicating that the target failed to validate.

Known Issues

- **Known Issue:**

Fix Version: 8.6.1

When it discovers a data delay in Hypervisor targets, analysis can stop generating actions, but it does not display a Health Check banner to alert you to the delay.

Turbonomic automatically detects delay in data collection for Hypervisor targets. If the data collection for a Hypervisor target takes five-times longer than usual, Turbonomic temporarily stops generating actions for the affected entities. When the delayed data condition resolves, Turbonomic resumes the generation of actions for the affected target.

Analysis can also display a banner to alert you to the data delay, but this banner is not currently enabled by default. To enable this banner, contact your Support representative.

- **Known Issue:**

Customer Issue 120842,121166

In a Nutanix environment, a Replace Hosts plan can fail to place VMs.

You can configure a Replace Hosts plan on a Nutanix cluster to replace the hosts with HCI templates. However, the plan will fail to create the HCI hosts, and will result in unplaced VMs.

- **Known Issue:**

When you view the details table for the Top Accounts chart, the Actions Taken and Saved By Actions columns can fail to show current data.

When viewing the Top Accounts chart, you can click **Show All** to see a details table. Under some circumstances, this table can fail to update with new data in the **Actions Taken** or **Saved By Actions** columns. For example, these columns can show zero even if you have taken actions that reduced costs.

To see current actions data, display the Executed Actions chart.

- **Known Issue:**

Hardware Refresh to replace hosts with HCI templates can fail to place workloads.

When running a Hardware Replace plan, the plan can fail to place workloads onto HCI hosts. The plan correctly places workloads if the plan scope is in a hyperconverged environment. If the scope is *not* in a hyperconverged environment, then you must scope the plan to an entire cluster, and you must configure the plan to replace all the hosts in the cluster with HCI templates.

- **Known Issue:**

Fix Version: 8.5.5

Customer Issue 120706

Under specific conditions, an update of the platform can cause it to lose all of its target configurations.

When updating Turbonomic from a version earlier than 8.5.3, if the username for any user accounts includes a % character, the update will fail to include your target configurations.

If this occurs when you update, contact your support representative for assistance.

Note:

You should always back up your installation before you run an update.

- **Known Issue:**

Fix Version: 8.5.3

Customer Issue 119952,120367

For AWS environments that have RI discount sharing turned off, analysis does not manage RI coverage and utilization.

In AWS, you can turn off RI discount sharing for specific accounts. These accounts will not share any discounts with other accounts. Turbonomic does not recognize RI coverage or utilization for these accounts. For example, the RI Coverage and RI Utilization charts will show zero values.

If you encounter this situation, contact your support representative for a possible workaround.

- **Known Issue:**

Fix Version: 8.5.1

Fix Version: 8.4.7.2

Customer Issue 119471,119789

For Headroom plans, you can specify the desired state for overprovisioned commodities.

Turbonomic runs nightly plans to calculate headroom in clusters; the number of VMs you can add to a cluster without exceeding limits for Memory, CPU, or storage. For example, if you want a desired state of 80% consumption, the plan will not add VMs that will exceed 80% utilization of resources in the cluster.

Note that reservations use these headroom calculations to determine whether Turbonomic can place the workloads in a reservation request.

By default, plans do not keep the utilization of overprovisioned resources within the desired state (80% in the above example). The plan calculates 100% utilization of overprovisioned resources. However, when placing reservations in the cluster, analysis could recommend provisioning new hosts as a way to keep the overprovisioned resources within the desired state.

We have introduced a setting you can make to enforce the desired state on overprovisioned resources. This can result in a lower calculated headroom. But when a reservation places and powers on a new VM, it is guaranteed to fit on the current infrastructure. Analysis will not see a need to provision a new host to support the VM's overprovisioned resources.

To turn on this feature, edit the topology-processor settings in the cr.yaml file:

1. Open an SSH terminal session on your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic.

2. Open the cr.yaml file for editing. For example:

```
vi /opt/turbonomic/kubernetes/operator/deploy/crds/
charts_v1alpha1_x1_cr.yaml
```

3. In the spec/properties section, find the entry for the topology-processor component.
4. Add the following properties to the component spec:

```
considerDesiredStateForProvisioningInClusterHeadroomPlan: true
considerUtilizationConstraintInClusterHeadroomPlan: true
```

5. Save and apply your changes to the platform.

After you save your changes, use kubectl to apply the changes:

```
kubectl apply -f /opt/turbonomic/kubernetes/operator/deploy/crds/
charts_v1alpha1_x1_cr.yaml
```

For assistance, contact your Support representative.

- **Known Issue:**

For Kubernetes, in some environments analysis cannot execute Scale Node actions.

For Kubernetes OCP 4.x and AKS environments, Turbonomic can generate and execute Scale Node actions. However, if the environment includes other K8s distributions that don't support execution of Scale Node actions (EKS, AKS, and OCP), then Turbonomic can disable execution of *all* Scale Node actions in the environment.

- **Known Issue:**

Fix Version: 8.4.3

Fix Version: 8.4.4

For Kubernetes environments with nodes running Linux with cgroup v2 enabled, you must use Kubernetes version 1.23.2 or later.

For Kubernetes environments with nodes running Linux with cgroup v2 enabled, an issue in earlier versions of Kubernetes prevents Turbonomic from collecting CPU utilization data for the affected nodes. To collect CPU utilization from the cgroup v2 nodes, you must run Kubernetes version 1.23.2 or later.

- **Known Issue:**

Fix Version: 8.4.6

Customer Issue 118620,119176

For very large environments, under rare circumstances queries can lock the database and cause gaps in discovered data.

For very large environments, it is possible for queries to lock the database, and cause gaps in discovered data. When this occurs you can see errors similar to the following:

- [RollupProcessor] : Error during rollup activity for table vm_stats_latest:
- [ComponentBasedTargetDumpingSettings] : Retaining 0 discovery dumps for target

If this occurs in your environment, contact your support representative for a workaround.

- **Known Issue:**

Billed costs shown in Turbonomic and Google Cloud Platform (GCP) do not match due to time differences.

Billed costs shown in Turbonomic charts and GCP billing reports do not match because Turbonomic uses UTC, while GCP uses local time. However, costs shown in both places are correct and reliable.

- **Known Issue:**

For IBM FlashSystem, a known FlashSystem issue can cause some models to show intermittent target errors.

For some models of IBM FlashSystem platforms, Turbonomic can show intermittent Invalid Credentials target errors. This is caused by a known FlashSystem REST service issue with platforms that have less than 64GB of memory.

If you experience this issue, use the following command to restart the FlashSystem REST service:

```
satask restartservice -service cfrest
```

Please contact your IBM FlashSystem Support representative for more information.

- **Known Issue:**

Fix Version: 8.4.3

Customer Issue 117905

For workloads with very large disks, Storage vMotion can time out.

Storage vMotion actions for VMs with very large disks can time out. If you experience this, contact your support representative for help changing the timeout threshold.

- **Known Issue:**

Fix Version: 8.3.3

Fix Version: 8.3.4

Customer Issue 117307

When updating your installation, under rare circumstances the Topology Processor component can fail to restart.

When updating Turbonomic, under rare circumstances the topology-processor pod can fail to restart. The log posts an error with the statement:

```
AccessDeniedException: /home/turbonomic/data/kv
```

If you experience this problem, please contact your support representative for a workaround.

- **Known Issue:**

For Azure, targets in the Australia Central region can show inconsistent pricing for VM license costs.

For Azure environments running in the Australia Central region, the pricing for license costs that is reported to Turbonomic can be incorrect. As a result, the user interface can display incorrect license costs for Linux or Windows operating system licenses.

- **Known Issue:**

For Azure and AWS, analysis does not consider the full cost for some workloads.

For Azure environments, analysis considers the base OS cost, but does not consider additional costs for support or other add-on features that are bundled with the OS. The affected OS types are Ubuntu PRO, SUSE 24/7, and RHEL with HA.

For AWS environments, analysis does not consider AWS Marketplace costs.

- **Known Issue:**

For certain installation configurations, an online update can take longer than expected.

If you have installed Turbonomic behind a firewall and opened ports for the Docker Hub services that deliver the Turbonomic, it is possible that the script `onlineUpgrade.sh` can take 30 to 45 minutes to complete. If you have trouble running the update, please contact your support representative.

- **Known Issue:**

Fix Version: 8.2.4

Fix Version: 8.2.5

After updating the platform, Embedded Reports can fail to display.

Under some circumstances, after you update Turbonomic to a new version, the Embedded Reports page can fail to display. The update appears to have completed successfully, but the Embedded Reports components appear to be running and ready. However, when you click on the Embedded Reports button, you get the following error:

```
failed to log in as user, specified in auth proxy header.
```

This can occur when the host VM takes a long time to completely start up all the platform components. If you encounter this problem, make sure all the components are running, and then execute the following command to restart the grafana pod:

```
kubectl delete pod -l app=grafana
```

For assistance, contact your support representative.

- **Known Issue:**

Fix Version: 8.3.4

Customer Issue 116930

For Fabric environments, when you scope the view to Datacenter the supply chain can fail to include all the related Host entities.

For environments that include Fabric targets, under some circumstances a view that you scope to the Datacenter might not include all the related Host entities. This can happen for hosts that include the hyphen character ("-") in the Host name. For example, for Cisco UCS targets, the supply chain will not show UCS hosts that use the hyphen character in their names when you scope to the Datacenter entity.

- **Known Issue:**

Fix Version: 8.3.3

Customer Issue 115635

For Azure, under some circumstances a successful scaling action appears in the logs as failed.

For Azure environments that include Availability Sets, under some circumstances a successful scaling action appears in the Turbonomic logs as failed.

- **Known Issue:**

Customer Issue 114942,118692

With Executed Actions charts, some data is missing for actions on entities that have been removed from the environment.

When you view Executed Actions charts or export data from them, some data is missing for actions on entities that have been removed from the environment. For example, assume an action was executed on a storage volume, and that volume has later been removed from the environment. In that case, the exported data for that action will not include values that describe the removed volume.

- **Known Issue:**

For Azure, if you connect the target through a proxy, then the target does not discover unattached storage volumes.

For Azure environments, if you connect to the Azure target through a proxy, then Turbonomic does not discover unattached volumes.

This issue occurs because the AzureVolumes probe must update the version of the azure-storage-sdk that it uses.

- **Known Issue:**

The Onboarding wizards can sometimes fail to close.

When you first install Turbonomic, the user interface displays onboarding wizards to walk you through setting up your license, and configuring your first target. Under some circumstances, the button to end the wizard's workflow does not close the wizard. That can result in blocking you from continuing your Turbonomic session.

If the onboarding wizard does not close when you click **End Setup**, refresh the browser. That should close the wizard and leave you on the last user interface page that you visited.

- **Known Issue:**

For Kubernetes environments, when you enable Feedback and Diagnostics for your installation, the collected data can include Kubernetes cluster names.

To help us improve the product, you can enable Turbonomic to collect anonymized and non-confidential data as you go about using the product. However, because of the way Kubernetes discovery works for Turbonomic, the collected data includes the names of any Kubernetes clusters that you have set up as targets. We do not make use of those cluster names in any way.

If you do not want Turbonomic to collect these cluster names, then you can navigate to **Settings / Maintenance Options / Feedback and Diagnostics** and turn off the option to share anonymized usage data.

- **Known Issue:**

Changes to a policy do not immediately show up in the user interface view of the affected scope.

When you set the scope of the Turbonomic view to a group, you can then view the automation policies that impact the given group. If you edit a policy for that group (in Settings: Policies), and then scope the view to that group again, the policy changes do not appear in the display for that group.

The display should update within ten minutes, after the next round of incremental discovery. If the condition persists, log out of your session and log in again to update the display.

- **Known Issue:**

Fix Version: 8.0.5

Customer Issue 113340

Hitachi Vantara targets can incorrectly show multiple compliance actions.

For Hitachi Vantara environments that enable storage replication, Turbonomic can generate repeated actions of the type, `Reconfigure Storage to Provide Extent`. In addition, replica storage entities and their providers can show incorrect utilization values.

- **Known Issue:**

Fix Version: 8.0.3

When creating an automation policy, you can assign two or more schedules to the Action Execution Schedule setting. If the action is one that cannot be executed by Turbonomic, then for Service Now integrations the action appears in the Change Requests for display, only. Also, such an action is *only* affected by the first schedule in the policy.

- **Known Issue:**

For Migrate to Cloud plans, under rare circumstances the plan's actions list can show duplicate entries.

For Migrate to Cloud plans, under rare circumstances the plan's actions list can show duplicate entries.

- **Known Issue:**

Fix Version: 8.0.1

For Azure environments, discovery does not support the Brazil Southeast region.

For Azure environments, Turbonomic does not discover the Brazil Southeast region. Azure provides this region only to give business continuity and disaster recovery to workloads in Brazil South that require data residence.

The user interface does not display the Brazil Southeast region in any lists or charts. Also, if you do have workloads on that region, Turbonomic will not discover those workloads.

- **Known Issue:**

For ServiceNow environments, Turbonomic fails to save any automation policy that sets the Action Type to **Request Approval from ServiceNow**.

- **Known Issue:**

Fix Version: 7.22.7

For AppDynamics environments, the platform cannot discover Database Servers if the target authentication uses OAuth for credentials.

For AppDynamics environments, Turbonomic cannot discover Database Servers if the target authentication uses OAuth for credentials.

- **Known Issue:**

For Application Component automation policies, the user interface allows you to make conflicting settings.

The Action Generation setting can show incorrect values that you can choose for the policy. As a result, you cannot save the policy.

- **Known Issue:**

Fix Version: 7.22.6

For ServiceNow environments, the user interface allows you to set orchestration for actions that the ServiceNow integration does not support.

For ServiceNow environments, the Turbonomic user interface allows you to set orchestration for actions that the ServiceNow integration does not support. If you configure orchestration for these actions, then either the action never generates a ServiceNow CR, or the action can fail when the CR is approved.

The actions you can configure but will not generate a CR are:

- Storage Suspend
- VSan Storage Resize

Note that storage resize for a VSan is accomplished by provision/suspend of Host. You should not configure ServiceNow orchestration for VSan Storage Resize. However, Host Provision is not currently supported for ServiceNow orchestration (see next).

- Host Provision
- File Delete
- Application Component - No actions are supported

The actions you can configure but that can fail include actions that you must also configure for execution on the affected targets. These actions include:

- Host Suspend

For this action to succeed, it must be enabled in the given hypervisor, and there must be no VMs currently running on that host.

- Storage Provision

Currently Turbonomic can only execute a CR for this action on Pure and Dell Compellent storage.

- **Known Issue:**

The user interface does not currently show the billed costs for some Azure resource groups.

For Azure environments, when you inspect resource groups, Turbonomic does not currently show the billed costs for those resource groups.

- **Known Issue:**

Customer Issue 111396

For cloud environments, under rare circumstances analysis can recommend resizing a VM to an instance type that is older and less capable than an equally priced instance type.

Under most circumstances, when a cloud provider offers a new instance type that is meant to replace an older type, the provider offers it at a lower cost. In at least one instance we have seen a case with identical costs for the newer and older instance types. If this occurs, and capacity and cost are equal, Turbonomic cannot ensure that it chooses the newer instance type.

To work around this issue, you can create an Action Automation policy that excludes the older instance type.

- **Known Issue:**

Fix Version: 7.22.0

The All Actions chart does not include pending actions for databases or database servers.

The All Actions chart does not include pending actions for databases or database servers.

- **Known Issue:**

Fix Version: 7.21.4

Customer Issue 110123

There is a memory limit for the data you can download from the All Actions chart.

There is a memory limit for the data you can download from the All Actions chart. For example, assume you have executed many actions over time in your environment. As a result, the list of all executed actions might exceed the data limit. In that case, downloading a CSV file from the All Actions chart will fail.

- **Known Issue:**

Fix Version: 7.22.1

Under rare circumstances, the etcd.service can fail.

Under rare circumstances the Turbonomic platform stops responding. This occurs when etcd.service fails. When it does occur, you should see the following error:

```
Error response from daemon: endpoint with name etcd1 already exists in network host
```

To recover from this situation, restart the docker service for the Turbonomic platform. execute the command: `sudo systemctl restart docker.service`

- **Known Issue:**

You must use certain templates when using PLACE to set up reservations or deployments.

When you use the **PLACE** page to set up a reservation or a deployment, you choose the templates to represent the workload you will deploy. The templates you choose must include an **Image** specification that gives the path to the VM package, and optional placement constraints.

Typically, you will use templates that are discovered through your hypervisor targets. Along with discovering resource capacities for the given VM, Turbonomic should also discover the Image specification for a given discovered template. However, in this version Turbonomic does not discover the Image descriptions. In addition, discovered templates and their image specifications are read-only. For this reason, you cannot set up placement or reservations using discovered templates.

- **Known Issue:**

For resources that do not support Reserved Capacity, charts can show them with zero reserved capacity.

Ring charts that show the utilization of different resources show a yellow segment whenever the Reserved Capacity for the resource is zero. For some resources there is no concept of reserved capacity, yet the ring chart still shows a yellow segment.

- **Known Issue:**

Optimized Improvements for plans do not include hosts to provision.

For cases where actions indicate provisioning new hosts, the Optimized Improvements chart does not include the hosts to provision in the After Plan section.

- **Known Issue:**

Fix Version: 6.1

Customer Issue 99189,99805

In vCenter environments, you might see high storage latency, or excessive storage provision.

In vCenter environments, you might see unusually high storage latency values or excessive recommendations to provision new storage. There is a known problem with the storage latency values that vCenter Server versions 6.5.u1x and earlier return via the API. These versions can return unusually high storage latency values.

Turbonomic considers storage latency when calculating whether to move a VM to existing storage, or whether to provision new storage. Because of this known problem, Turbonomic can incorrectly recommend provisioning storage when moves are appropriate.

If you encounter this problem, then you should create a policy that disables storage moves for VMs that are managed by vCenter Server versions 6.5.u1x and earlier. To create this policy:

- Create a VM group that contains all the affected VMs. Note that Turbonomic automatically creates a group named `VMs_vCenter` that you might be able to use.
- Create a new VM automation policy. This policy will disable storage move actions.
- Set the group that you created to be the policy scope.
- Under **Action Automation** add the Storage Move action and set it to Disabled.

- **Known Issue:**

The Optimal Improvements chart can show incorrect data for hosts to be suspended.

In cases where actions recommend that you suspend hosts, the Optimal Improvements chart should indicate no utilization on the hosts to be suspended. Under some circumstances, the chart can show utilization on these hosts. The result is incorrectly low values for utilization on the other hosts in the current scope.

- **Known Issue:**

For vSAN environments, under some circumstances a plan that is scoped to a datacenter can fail.

For vSAN environments, when running plans that add or replace hosts to the environment, under some circumstances the plan can show the incorrect count for hosts, and the plan can fail.

This can happen for plans that meet the following conditions:

- The plan type is Hardware Refresh, Add Workload, or Custom
- The plan scope is set to a datacenter, and it includes vSAN hosts
- The plan uses an HCI template to replace the hosts

After running, the plan shows the full count of hosts in the vSAN environment, instead of the count of hosts in the plan scope.

To avoid this situation, do not scope the plan to the datacenter.

- **Known Issue:**

Customer Issue 105693

The Headroom chart for All On-prem Hosts does not always agree with the Top Clusters chart.

The Headroom chart for All On-prem Hosts does not always agree with the Top Clusters chart.

Turbonomic generates the All On-prem Hosts headroom data in a nightly plan. When the plan runs, this data is correct. In the course of the day, this data can become stale.

To accurately track your cluster usage, you should use the Top Clusters chart.

- **Known Issue:**

For vCenter Server environments, Turbonomic does not recognize DRS rules for VM restart dependencies that are based on `ClusterDependencyRule`.

For vCenter Server environments, Turbonomic does not recognize DRS rules for VM restart dependencies that are based on `ClusterDependencyRule`.

You might be able to achieve a similar effect by expressing dependencies via `ClusterVmHostRule` or cluster affinity or antiaffinity rules.

REST API Changes

July 27, 2022

This document describes issues that result in changes to the REST API. It is a running list of changes that accumulates until the next release of the API Programming Guide. When we release a new version of the programming guide, it will include these changes. At that time, this list will start with new changes to the API.

Because the API is a full reflection of the Turbonomic product, some changes to the product necessarily cause changes in the API. This can include bug fixes and improvements to the product. For example, we might add new commodities that you can get for a given entity type. Or a bug fix might change the data that is returned by an API request. We strive to make these changes backward-compatible whenever possible.

In some instances, we must make changes that are not backward-compatible. In this case, we deprecate the change for a period of time that should be sufficient for you to understand the change and implement an alternative in your scripts.

- For a list of upcoming deprecations, see [API Deprecation Contract](#).

REST API Changes

For this release (version 8.6.0), there are no new API changes to report. API changes from the previous version family are incorporated in the new API Guide.

Appendix: API Deprecation Contract

The following endpoints, requests, DTOs, and parameters are deprecated in the Turbonomic API. The End of Life (EOL) gives the product version in which we will finalize these changes, and will no longer offer the deprecated items.

Note:

See the instructions for alternative usage for deprecated items with a defined EOL.

EOL: Not Determined

We deprecate the following features, but we have not determined which Turbonomic version marks their End of Life.

Endpoints	None
Requests	None
Request Parameters	None
DTOs	<ul style="list-style-type: none">• DTO: ScenarioChangeApiDTO Instruction: Use the loadChanges or configChanges parameters in the ScenarioApiDTO.
DTO Parameters	<ul style="list-style-type: none">• DTO: ScenarioApiDTO Parameter Name: changes Instruction: Use the loadChanges or configChanges parameters.

EOL: 8.6.1

Behavior Changes:

- Pagination of Returned Data from /search requests:

For searches, the API paginates the returned data. If you do not specify a pagination limit, then the API returns pages set to the default limit. Starting with version 8.6.1, the default and max pagination limits for search data will be 500. You can set pagination to less than 500, but if your search results include

more than 500 entries, the results will be paginated. Your scripts should always check for a pagination cursor when processing search results.

We will make the following deprecation changes in the 8.6.1 release. These deprecated features will be removed from the API at that time.

Endpoints	None
Requests	None
Request Parameters	None
DTOs	<ul style="list-style-type: none"> ReportScheduleApiDTO <p>This release will remove ReportScheduleApiDTO.</p>
DTO Parameters	<ul style="list-style-type: none"> DTO: ActionApiDTO Parameter Name: CurrentLocation Instruction: The object in this parameter will only contain the following fields: <ul style="list-style-type: none"> links uuid className displayName discoveredBy environmentType vendorIDs DTO: ActionApiDTO Parameter Name: NewLocation Instruction: The object in this parameter will only contain the following fields: <ul style="list-style-type: none"> links uuid className displayName discoveredBy environmentType vendorIDs DTO: ProductVersionDTO Parameter Name: buildUser

	<p>Instruction: Deprecated with no replacement. This parameter was not set in the 8.x product family.</p> <ul style="list-style-type: none"> • DTO: GroupApiDTO <p>Parameter Name: <code>remoteId</code></p> <p>Instruction: Deprecated with no replacement. This parameter was not set in the 8.x product family.</p> <ul style="list-style-type: none"> • DTO: UserApiDTO <p>Parameter Names:</p> <ul style="list-style-type: none"> – <code>roleUuid</code> – <code>roleName</code> <p>Instruction: Deprecated. Use the <code>roles</code> parameter in UserApiDTO.</p>
--	--

EOL: 8.7.1

We will make the following deprecation changes in the 8.7.1 release. These deprecated features will be removed from the API at that time.

Endpoints	None
Requests	<ul style="list-style-type: none"> • DELETE <code>/entities/<entityId>/tags/<tagKey></code> Instead, use DELETE <code>/entities/<entityId>/tags?key=<tagKey></code> • DELETE <code>/groups/<groupId>/tags/<tagKey></code> Instead, use DELETE <code>/groups/<groupId>/tags?key=<tagKey></code>
Request Parameters	None
DTOs	<ul style="list-style-type: none"> • LicenseApiInputDTO <p>Instruction: Use LicenseApiDTO.</p>
DTO Parameters	<ul style="list-style-type: none"> • DTO: HttpProxyDTO Parameter Name: <code>portNumber</code> Instruction: Use <code>proxyPortNumber</code>. • DTO: LogEntryApiDTO Parameter Name: <code>reasonCommodity</code> Instruction: Use the array, <code>reasonCommodities</code>.

EOL: 8.8.1

We will make the following deprecation changes in the 8.8.1 release. These deprecated features will be removed from the API at that time.

Endpoints	None
Requests	<ul style="list-style-type: none"> • GET <code>/search/market/</code> Instead, use GET <code>/markets</code>

	<ul style="list-style-type: none"> • GET /search/target/ Instead, use GET /targets • GET /groups/<groupId>/actions/<actionId> Do not use this call. • GET, POST /target/<targetId>/stats Do not use this call. • GET /businessunits/<busUnitId>/stats Instead, use GET /entities/<entityId>/stats or GET /stats/<entityId>/stats. These calls use the business unit entity ID. • POST /businessunits/<busUnitId>/stats Instead, use POST /stats/<entityId>/stats or POST /stats.
Request Parameters	None
DTOs	None
DTO Parameters	None
ENUM Values	<ul style="list-style-type: none"> • entityType:VMSpec Use VirtualMachineSpec instead • entityTypes:VMSpec Use VirtualMachineSpec instead • entityTypeFilter:VMSpec Use VirtualMachineSpec instead • providerEntityType:VMSpec Use VirtualMachineSpec instead • relatedEntityType:VMSpec Use VirtualMachineSpec instead • providerType:VMSpec Use VirtualMachineSpec instead

Appendix: API Deprecation History

The following endpoints, requests, DTOs, and/or parameters have been deprecated in the Turbonomic API. The End of Life (EOL) gives the product version in which we finalized these changes, and no longer support the deprecated items.

EOL: 8.5.1

Behavior Changes:

- Pagination of Returned Data

The default pagination will change for the following requests:

- GET /groups
- GET /groups/<groupId>/members

- GET /groups/<groupId>/entities
- GET /targets/<targetId>/entities
- GET /tags
- GET /tags/{tagKey}/entities

To paginate returned data, the `limit`, `orderBy`, and `cursor` parameters control how the APIs paginate their data. Currently if you specify any one of these parameters, the API paginates the returned data. If you do not specify any of these parameters, the API does not paginate the output, and it returns an unlimited set of data.

Starting with version 8.5.1, if you do not specify a `limit` for these requests, the API will paginate the data to a default limit. If your scripts make these requests without setting a limit, you should update them to check for a pagination cursor in the returned data.

We made the following deprecation changes in the 8.5.1 release. These deprecated features were removed from the API at that time.

Endpoints	None
Requests	<ul style="list-style-type: none"> Request: GET /users/onetimepassword Instruction: Deprecated with no replacement. This is not required for any Turbonomic activities.
Request Parameters	None
DTOs	None
DTO Parameters	None

EOL: 8.4.3

We made the following deprecation changes in the 8.4.3 release. These deprecated features were removed from the API at that time.

Endpoints	None
Requests	None
Request Parameters	<ul style="list-style-type: none"> Request: GET /search Parameter Name: <code>regex</code> Instruction: Use the <code>queryType</code> parameter.
DTOs	<ul style="list-style-type: none"> DTO: <code>StatPercentileApiDTO</code> Instruction: Use <code>StatHistUtilizationApiDTO</code> .
DTO Parameters	<ul style="list-style-type: none"> DTO: <code>ActionApiDTO</code> Parameter Name: <code>resizeToValue</code> Instruction: Use the <code>newValue</code> parameter. <ul style="list-style-type: none"> DTO: <code>ActionScopesApiDTO</code> Parameter Name: <code>limitEntities</code> Instruction: Use the <code>limit</code> parameter.

	<ul style="list-style-type: none"> • DTO: BillingFamilyApiDTO Parameter Name: uuidToNameMap Instruction: Use the businessUnitApiDTOList parameter. • DTO: BusinessUnitApiDTO Parameter Name: hasRelatedTarget Instruction: Use the associatedTargetId parameter. • DTO: ScopeUuidsApiInputDTO Parameter Name: topologyContextId Instruction: Use the marketId parameter. • DTO: StatApiDTO Parameter Name: percentile Instruction: Use the histUtilizations parameter. • DTO: TargetApiDTO Parameter Name: currentBusinessAccount Instruction: Use the associatedTargetId parameter of the BusinessUnitApiDTO.
--	---

Chapter 3. Installation

This guide gives you information you need to install Turbonomic in your virtual environment, install your license, and get started managing your resources.

If you have any questions, please contact IBM support. Visit our support site at <https://support.turbonomic.com>.

Minimum Requirements

License Requirements

To run Turbonomic on your environment, you must install the appropriate license. Licenses enable different sets of Turbonomic features, and they support a specified number of workloads in your environment.

User Interface Requirements

To display the Turbonomic user interface, you must log into the platform with a browser that can display HTML5 pages. Turbonomic currently supports the following browsers:

- Apple Safari
- Google Chrome
- Microsoft Edge
- Mozilla Firefox

Network Addressing Requirements

Turbonomic requires static IP addressing. Static IP setup is covered as a step when installing the Turbonomic VM image.

Compute and Storage Requirements

The requirements for running a Turbonomic instance depend on the size of the environment you are managing. Turbonomic keeps a real-time representation of your environment in memory. The greater the number of entities to manage, and the more extensive the relationships between them, the more resources you need for the VM that runs Turbonomic. And as the VM requirements increase, so do the requirements for the physical machine that hosts the VM.

The requirements listed here are recommendations that you should keep in mind as you plan your Turbonomic deployment. After deploying, if you find that you need to change memory capacity, CPU capacity, or both for the VM, you can shut it down, make changes, and then power it up again to use the new capacity.

Note:

The machine that hosts the Turbonomic platform must support the SSE4.2 instruction set. Support for this instruction set was introduced at different times for different chip manufacturers:

- Intel: November 2008
- AMD: October 2011

The machine you use to host Turbonomic should be newer than these dates. On a Linux system, you can run the following command to check for this support:

```
cat /proc/cpuinfo | grep sse4
```

For more information, see the glossary entry at <http://www.cpu-world.com/Glossary/S/SSE4.html>.

In most cases you can run Turbonomic on a host that meets the following minimum requirements:

Supported VM Image Technology	Storage Requirements	Memory	CPUs
VMware vCenter versions 5.5, 6.0, 6.5, 6.7, and 7.0	1.25 TB or greater. Note:	<ul style="list-style-type: none">• Default: 128 GB• For 10,000 VMs or less, 64 GB	8 vCPUs
Microsoft Hyper-V Server 2012 R2 or later	Can be thin provisioned depending on the storage requirements.		

IBM provides a VM image (an OVA or VHD file) which is preconfigured with two hard drives. A minimum of 1.25 TB is necessary to ensure that the drives have the proper amount of space for storage.

Installing on a Virtual Machine Image

You can get a download of the Turbonomic platform as a:

- VMware OVA 1.0 image
- Microsoft Hyper-V image

Note:

For minimum requirements, we recommend 128 GB of memory for the VM that hosts Turbonomic. However, if you plan to manage a smaller environment (10,000 VMs or less), you can install on a VM that provides 64 GB of memory. (See [Minimum Requirements](#)).

If you plan to install a VM with 64 GB of memory, then you must modify the default for VM memory. (See [Deploy the Turbonomic VM](#)).

You will install the platform in two main steps:

1. Install the Turbonomic VM image on your network.

This installs and starts up the VM that will host your instance of the Turbonomic platform.

2. Deploy the Turbonomic components on the VM.

About the Turbonomic VM Image

Turbonomic installs as a VM that runs the CentOS Linux OS. For each new version, we deliver a VM image (OVA or VHD) that you install to run the product. Typically you install this image once, and for subsequent updates to Turbonomic you will execute product updates on that installed VM. This means two things:

- Product updates patch new components of the Turbonomic application stack onto the same CentOS platform that you got when you originally installed the VM image. Product updates do not affect the underlying OS.
- Over time, you might learn of important security patches for the CentOS distribution. It is your responsibility to keep the OS up to date. You can install these patches on your Turbonomic VM whenever necessary.

Note:

We currently release the VM image with the CentOS Linux OS. We have found it to meet overall security requirements. We intend to continue with CentOS for as long as that platform remains viable and secure.

Turbonomic Updates

IBM continually and rapidly innovates and improves all aspects of this product. This means that we periodically release product updates for you to install. For more information about installing updates, see [Updating Turbonomic to a New Version](#).

Turbonomic installs as a Kubernetes cluster on the VM. When you do update the product, the update can change:

- The application stack

This comprises a number of components and services such as:

- Application services for the user interface, analysis, and other product components.
- The historical database.
- Probes – Components that implement the different targets you can configure.

For a full list of components in the application stack, you can inspect the platform's `cr.yaml` file.

- Datastores

The installation configures persistent and ephemeral storage for the Turbonomic product to use.

- Cluster configuration and management services

This includes Kubernetes Operator, and associated Kubernetes configuration files.

OVA: Installing the vCenter Image

The first step to installing Turbonomic is to deploy the VM that will host the platform. For vCenter environments, we deliver an OVA image for each bi-weekly release.

Note:

For minimum requirements, we recommend 128 GB of memory for the VM that hosts Turbonomic. However, if you plan to manage a smaller environment (10,000 VMs or less), you can install on a VM that provides 64 GB of memory. (See [Minimum Requirements](#)).

If you plan to install a VM with 64 GB of memory, then you must modify the default for VM memory. (See [Deploy the Turbonomic VM](#)).

To install the Turbonomic OVA:

1. Download the Turbonomic installation package.

The email you received from IBM includes links to the Turbonomic download pages. You can get the installation package from there.

The installation package includes the `turbonomic_t8c-<version>-<XXXXXXXXXXXXXXX>.ova` file where `<version>` is the Turbonomic version number and `<XXXXXXXXXXXXXXX>` is the timestamp.

For example: `turbonomic-t8c-8.0.5-20190916164429000.ova`

The OVA file deploys as a VM with the Turbonomic components ready for installation.

2. Import the OVA file into your datacenter.

Use the vCenter Server client to import the OVA into your environment.

3. Deploy the Turbonomic VM.

Configure the VM that was deployed from the OVA file.

For minimum requirements, we recommend 128 GB of memory for the VM that hosts Turbonomic. However, if you plan to manage a smaller environment (10,000 VMs or less), you can install on a VM that provides 64 GB of memory. (See [Minimum Requirements](#)).

If you want to deploy a VM with 64 GB of memory, manually modify the default value for Memory:

- a. Right-click the VM and choose **Edit Settings**.

- b. Type **64** for Memory.
 - c. Click **OK** to save the settings
 - d. Power on the VM.
4. Open the remote console.

For the Turbonomic VM that you just deployed:

- a. Choose the **Summary** tab.
 - b. Click **Launch Remote Console**.
5. Set up the Turbonomic System Administrator account.
 - a. In the remote console, log in with the following default credentials:
 - Username: turbo

Do not use the account name, root.

 - Password: vmturbo

Then, you will be prompted to enter a new password.
 - b. Enter your new password.

The new password must comply with the strong password policy (a mixture of upper- and lower-case letters, numbers, and a symbol). Only you will know this new password.

Note:

Be sure to save the changes account credentials in a safe place. For security reasons, this is the only account that can access and configure the Turbonomic VM.

- c. Enter your new password again to verify it.
6. Update the root password.

The platform uses the root account for certain processes, such as rolling up log messages in `/var/log/messages`. To ensure the account credentials are current, you must change the password:

- a. Open a SuperUser session.
 - In the remote console, enter `su -`
 - At the password prompt, enter the default password: vmturbo
- b. Reset a new password.

After you log in as root with the default password, the system prompts you for a New password. This new password must comply with the strong password policy (a mixture of upper- and lower-case letters, numbers, and a symbol). Only you will know this new password.

Note:

Be sure to save the root account credentials in a safe place.

- c. Exit the SuperUser session.

Enter `exit`.
7. Set up the static IP address.

Operation and management of the Turbonomic platform both require a static IP address for the VM. The installed VM includes the `ipsetup` script to perform this task. To run the script, execute the following:

```
sudo /opt/local/bin/ipsetup
```

When the script runs it requests the following inputs.

Note:

You must provide values for these required fields. Otherwise the installation can fail or your VM can be unreachable:

- **Required:** Do you want to use DHCP or set a static IP...
Choose static
- **Required:** Please enter the IP Address for this machine
- **Required:** Please enter the network mask for this machine
- **Required:** Please enter the Gateway address for this machine
- **Required:** Enter DNS Server(s) IP Address for this machine

You should make a note of the IP address that you provide.

As part of running `ipsetup`, you can configure a proxy for internet access. To verify that your proxy has been properly set, first complete the full installation procedure. After you run the installation you can view the proxy configuration in `/etc/systemd/system/docker.service.d/http-proxy.conf`. Find the `[Service]` section. It should contain your proxy and `no_proxy` settings. For example, it should be similar to:

```
Environment="HTTP_PROXY=http://10.10.12.34:3123" "NO_PROXY=<YourStaticIP>, node1, 127.0.0.1, 127.0.0.0"
```

8. Perform other necessary configuration steps, and then install the Turbonomic components.

To perform the required and important configuration steps for the Turbonomic instance, see [General Configuration Tasks](#).

To install the Turbonomic components, see [Deploying the Turbonomic Components](#).

VHD: Installing the Microsoft Hyper-V Image

The first step to installing Turbonomic is to deploy the VM that will host the platform.

For Hyper-V environments, we deliver a Hyper-V image for each quarterly release. If you want to run Turbonomic on a Hyper-V VM, you can install the Quarterly Release, and then update to a later point release if necessary.

Note:

For minimum requirements, we recommend 128 GB of memory for the VM that hosts Turbonomic. However, if you plan to manage a smaller environment (10,000 VMs or less), you can install on a VM that provides 64 GB of memory. (See [Minimum Requirements](#)).

If you plan to install a VM with 64 GB of memory, then you must modify the default for VM memory. (See [Deploy the Turbonomic VM](#)).

To install Turbonomic:

1. Download the Turbonomic installation package.
The email you received from IBM includes links to the Turbonomic download pages. You can get the installation package from there.
2. Expand the .zip file and copy the contents, which includes the Virtual Machine image, to your Hyper-V server (either to your cluster shared volume or to a local hard drive).
3. Use the Import Virtual Machine Wizard in the Hyper-V Manager to import the Virtual Machine into your environment.
4. Make sure your virtual network adapter is connected to the correct virtual network.
5. Ensure the Turbonomic instance will have sufficient memory.

IBM recommends that you use static memory for your Turbonomic instance. However, you can specify static or dynamic memory for the instance. By default, the installation sets static memory to 128 GB.

6. Start the Turbonomic appliance and record its IP address.

7. Set up the Turbonomic System Administrator account.

a. Log into the VM's Hyper-V console with the following default credentials:

- Username: turbo

Do not use the account name, root.

- Password: vmturbo

Then, you will be prompted to enter a new password.

b. Enter your new password.

The new password must comply with the strong password policy (a mixture of upper- and lower-case letters, numbers, and a symbol). Only you will know this new password.

Note:

Be sure to save the changed account credentials in a safe place. For security reasons, this is the only account that can access and configure the Turbonomic VM.

c. Enter your new password again to verify it.

8. Update the root password.

The platform uses the root account for certain processes, such as rolling up log messages in `/var/log/messages`. To ensure the account credentials are current, you must change the password:

a. Open a SuperUser session.

- In the remote console, enter `su -`
- At the password prompt, enter the default password: vmturbo

b. Reset a new password.

After you log in as root with the default password, the system prompts you for a New password. This new password must comply with the strong password policy (a mixture of upper- and lower-case letters, numbers, and a symbol). Only you will know this new password.

Note:

Be sure to save the root account credentials in a safe place.

c. Exit the SuperUser session.

Enter `exit`.

9. Set up the static IP address.

Operation and management of the Turbonomic platform both require a static IP address for the VM. The installed VM includes the `ipsetup` script to perform this task. To run the script, execute the following:

```
sudo /opt/local/bin/ipsetup
```

When the script runs it requests the following inputs.

Note:

You must provide values for these required fields. Otherwise the installation can fail or your VM can be unreachable:

- **Required:** Do you want to use DHCP or set a static IP...

Choose static

- **Required:** Please enter the IP Address for this machine
- **Required:** Please enter the network mask for this machine
- **Required:** Please enter the Gateway address for this machine
- **Required:** Enter DNS Server(s) IP Address for this machine

You should make a note of the IP address that you provide.

As part of running `ipsetup`, you can configure a proxy for internet access. To verify that your proxy has been properly set, first complete the full installation procedure. After you run the installation you can view the proxy configuration in `/etc/systemd/system/docker.service.d/http-proxy.conf`. Find the `[Service]` section. It should contain your proxy and `no_proxy` settings. For example, it should be similar to:

```
Environment="HTTP_PROXY=http://10.10.12.34:3123" "NO_PROXY=<YourStaticIP>, node1, 127.0.0.1, 127.0.0.0"
```

10. Enable the NIC for the installed VM.

The Turbonomic instance configuration includes one NIC, but it is not enabled or connected to a network. Display the NIC in the Hyper-V Manager and enable it.

11. Perform other necessary configuration steps, and then install the Turbonomic components.

To perform the required and important configuration steps for the Turbonomic instance, see [General Configuration Tasks](#).

To install the Turbonomic components, see [Deploying the Turbonomic Components](#).

Deploying the Turbonomic Components

Note:

This section describes the default installation process. If you want to customize your installation, then you should consider taking the steps in [Appendix: Stepwise Platform Deployment](#).

For example, to change the Kubernetes host name for the deployment, you must perform a stepwise installation.

After you have installed the Turbonomic VM that will host the platform, you can install the platform components, as follows:

First, gather the information you will need to run the installation:

- Network Time Source for Time Synchronization (optional)

You can perform this step during installation, or at a later date. If you want to synchronize the VM's clock now, you will be prompted for the Network Time Source. For more information about synchronizing the VM's clock, see [Synchronizing Time](#).

- Your updated root password

The installation script requires that you have updated the root password for the VM. If you followed the instructions in [OVA: Installing the vCenter Image](#) or in [VHD: Installing the vCenter Image](#), then you should have already performed this step.

When you are ready with the necessary information, you can run the installation script.

1. Start up the installation script.

- Start a secure session (SSH) on your Turbonomic VM as the `turbo` user.
- Change to the scripts directory:

```
cd /opt/local/bin/
```

- Execute the installation script:

```
sudo t8cInstall.sh
```

2. Verify that you have configured a static IP address for the Turbonomic VM.

As a first step, the script prompts you with:

```
Have you run the ipsetup script to setup networking yet? [y/n] n
```

If you have not configured a static IP for the platform VM, enter n to exit the installation script now, and configure a static IP.

If you have already configured a static IP for the platform VM, enter y to continue the installation. The script output displays the IP address that it recognizes for the VM, for example:

```
-----  
Old IP Address: 10.0.2.15  
New IP Address: 10.10.123.123  
-----
```

Note:

Because of dependencies between the platform components and the VM address, you cannot easily change the IP address after you have installed the components. For a production installation of Turbonomic, the VM must run with a static IP. For a testing or evaluation installation, you can use DHCP. However, if you plan to later use such an installation in a production environment, you should be sure to configure a static IP.

If you followed the instructions in [OVA: Installing the vCenter Image](#) or in [VHD: Installing the vCenter Image](#), then you should have already run the `ipsetup.sh` script to do this.

3. Wait while the script performs the installation.

As the installation process continues, the script:

- Configures the platform environment with the necessary certificates
- Configures the Kubernetes cluster on the VM

This can take a few tries before it succeeds. For each try that does not succeed, you will see messages similar to:

```
To further debug and diagnose cluster problems, use 'kubectl cluster-info dump'.
```

When the connection succeeds, the script advances to the next steps.

- Establishes local storage for the platform
- Creates the kubernetes namespace for the platform as `turbonomic`
- Configures authorization to access the required Kubernetes secrets
- Initializes the MariaDB database server to manage historical data for the platform

The script creates two accounts on the MariaDB that have full privileges:

- `root@localhost`

This account does not use a password. To connect via this account the user must be `system root`.

- `mysql@localhost`

This account does not use a password. To connect via this account the user must be `system mysql`.

Note:

For security reasons, IBM recommends that you configure passwords for these accounts. You can connect with these accounts via `sudo`. For example, `sudo mysql`. After you connect, you can then

set passwords to these accounts. For more information, see the MariaDB Knowledgebase at <https://mariadb.com/kb>.

- Installs the Timescale database for Embedded Reports and the Data Exporter
- Deploys and starts up the platform components

As the deployment begins, the script prints out the following:

```
#####  
Start the deployment rollout  
#####
```

After it deploys the components, it waits for the components to start up:

```
The installation process is complete, waiting for all the components to start up.  
** The script will wait for as long as 30 minutes. **
```

If the components all start up within 30 minutes, then the installation is complete and successful.

If the components do not all start up within 30 minutes, the script displays the following and then exits:

```
=====
One or more of your deployments has not started up yet.
** Please give your environment another 30 minutes to stabilize. **
To check the status of your components, execute the following command:
kubectl get pods
If some components are still not ready, contact your support representative
Deployments not ready:
```

The script then displays the formatted result of the `kubectl get pods` command. This shows you the current status of the pods in the Turbonomic platform.

Note:

If the script exits before the components have all started up, we recommend that you give the platform another 30 minutes. To periodically check the component status, execute `kubectl get pods`. If the components do not all start up after you have waited another 30 minutes, contact your support representative.

If the installation is successful and the components have all started up, the script displays a message similar to the following, where it gives the VM's static IP address:

```
#####  
Deployment Completed, please login through the UI  
https://10.10.123.123  
#####
```

You can move on to the next steps.

4. Save a copy of the platform's Master Key secret.

The installation procedure creates a Master Key secret in the Kubernetes cluster. Turbonomic uses this secret to provide access for the platform components. You should save the key data to a safe location. If for some reason the key data gets corrupted or is otherwise unusable, Turbonomic will fail to operate. If this happens, you can contact your support representative and use this saved data to recover your platform.

To save the data:

- a. List the platform secrets.

Execute the command:

```
kubectl get secrets
```

The results should include the Master Key secret, similar to the following:

```
...
master-key-secret          Opaque          1          57d
...
```

b. Display the Master Key data.

Once you find the Master Key name, you can then display the key data:

```
kubectl get secret master-key-secret -o yaml
```

The command result should be similar to the following:

```
apiVersion: v1
data:
  primary_key_256.out: AfnJWutxNHAduaIOdAii3DRA2fMa6lzX4rWetZxxZvc=
kind: Secret
metadata:
  creationTimestamp: "2021-06-30T02:59:19Z"
  managedFields:
  - apiVersion: v1
    fieldsType: FieldsV1
    fieldsV1:
      f:data:
        .: {}
        f:primary_key_256.out: {}
      f:type: {}
    manager: kubectl-create
    operation: Update
    time: "2021-06-30T02:59:19Z"
  name: master-key-secret
  namespace: turbonomic
  resourceVersion: "1072"
  uid: a314b2ba-2061-4b41-b844-56caf2c3728d
  type: Opaque
```

The important key data to save is the `primary_key . . . data`. In the above example, you should save the line:

```
primary_key_256.out: AfnJWutxNHAduaIOdAii3DRA2fMa6lzX4rWetZxxZvc=
```

c. Save the data to a safe place.

Write this data to a file and save it in a safe backup location. If you ever need to recover the Master Key, your support representative will use this data to perform the recovery.

5. Log in to the Turbonomic user interface and set the administrator user account password.

After the components start up, go to your Web browser and type the static IP address of your Turbonomic VM. Your browser redirects the login page for Turbonomic users.

Turbonomic includes a default user account named `administrator` which has an `ADMINISTRATOR` role. As you log in for the first time, you must set your own password for that account. You can create or delete other accounts with the `ADMINISTRATOR` role, but your installation of Turbonomic must always have at least one account with that role.

In the login page, enter the information as required, and make a note of it.

- Use the default credential for **USERNAME**: `administrator`.
- Type a password for **PASSWORD**.

The new password must comply with the strong password policy (a mixture of upper- and lower-case letters, numbers, and a symbol). Only you will know this new password.

- Type the password again to verify it for **REPEAT PASSWORD**.
- Click **CONFIGURE**.

This is the account you will use to access the Turbonomic user interface with `administrator` permissions. *Be sure to save the user interface administrator account credentials in a safe place.*

Note:

The initial login is always for the administrator account. This is an administration *user* account. Do not confuse this with the Turbonomic System Administrator account that you previously set up to log into shell sessions on the VM itself.

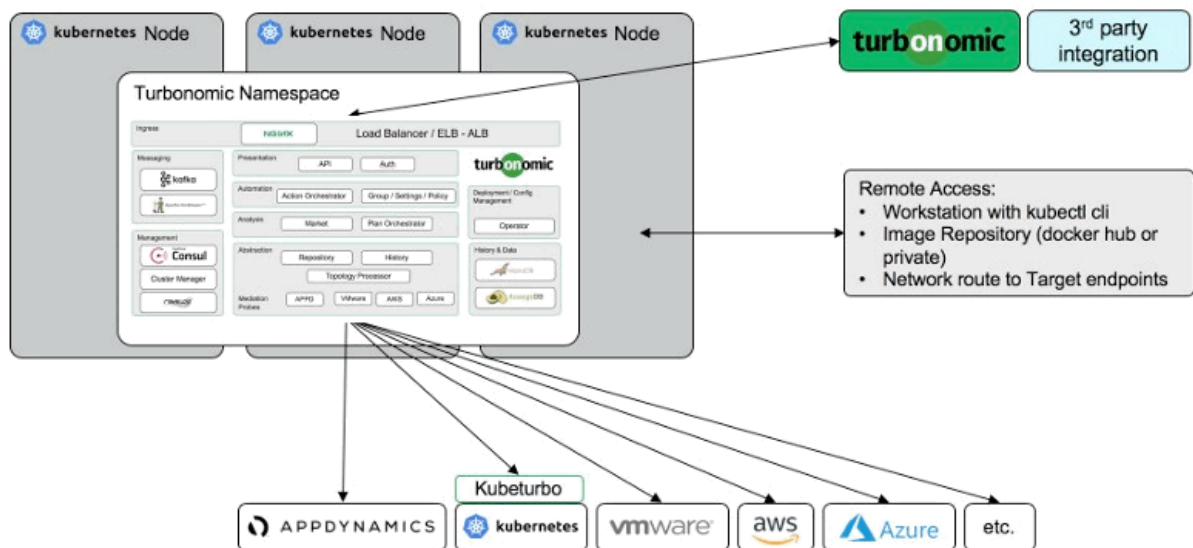
6. After you have logged in as administrator, you can create other user accounts, and you can give them various roles. For more information about user accounts and roles, see the *Turbonomic User Guide*.

Note:

For security reasons, you can create a different administrator user account to serve as the main administrator of your Turbonomic installation, and then delete the default administrator account. But remember, *you must always have at least one user account with administrator privileges*.

Installing on Kubernetes Nodes

You can deploy Turbonomic to a node cluster on Kubernetes or to OpenShift platforms.



Turbonomic is a containerized microservices platform that installs on a node cluster in a single namespace deployment. The platform uses Operator to deploy, manage and run the IBM components. Operator includes a configuration file that you can use to adjust your setup.

Note that as part of your deployment, you can take advantage of the backup and HA capabilities of an external database service running outside of the node cluster. You can also deploy using the default database component, or using an external database service for the historical database.

For more information, see the instructions to install on Kubernetes nodes at <https://github.com/turbonomic/t8c-install/wiki>.

General Configuration Tasks

After you install the Turbonomic instance, you should perform the following configuration tasks:

- (Required) Synchronize the system clock and configure your time servers.
- (Important) Verify your MariaDB version.
- (Important) Increase your database capacities.
- (Optional) Increase available disk space.
- (Optional) Enforce secure access via LDAP.

- (Optional) Enforce secure access via trusted certificate.
- (Optional) Enable secure access for probes.
- (Optional) Modify the certificates for Cluster Manager.
- (Optional) Integrate Turbonomic with IBM DataCloud
- (Optional) Enable embedded reports.
- (Optional) Enable the Data Exporter.
- (Optional) Change the IP address of the platform node.
- (Optional) Enable and disable probe components.

(Required) Synchronizing Time

It is important that you synchronize the clock on the Turbonomic instance with the other devices on the same network. By default, the Turbonomic server is configured to synchronize with any one of the following time servers:

- 0.centos.pool.ntp.org
- 1.centos.pool.ntp.org
- 2.centos.pool.ntp.org
- 3.centos.pool.ntp.org

To synchronize with these servers, your installation of Turbonomic must have access to the internet. If your environment restricts internet access, then you have to configure synchronization with a time server on your network.

In all cases, you should verify that the Turbonomic clock is properly synchronized. To check the system clock:

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Username: [your_private_password]

2. Verify your time settings.

Execute the date command. You should see results similar to:

```
Thu Feb 2 14:25:45 UTC 2019
```

To verify the time, you can execute the command, `timedatectl`. The output should be similar to:

```
Local time: Fri 2019-12-06 21:09:26 UTC
Universal time: Fri 2019-12-06 21:09:26 UTC
RTC time: Fri 2019-12-06 21:09:27
Time zone: UTC (UTC, +0000)
NTP enabled: yes
NTP synchronized: yes
RTC in local TZ: no
DST active: n/a
```

This tells you whether you have NTP enabled, and whether it is currently synchronized, along with other time synchronization information.

If the output is correct *and* your environment has access to the internet, you can assume the system clock is synchronized.

If the output is incorrect, or if you need to configure synchronization with a time server on your network, you must configure `chrony` on the server instance.

To set up `chrony` on your Turbonomic instance:

1. Open an SSH terminal session to your Turbonomic instance.

2. Open the chrony configuration file.

For example, execute the command: `sudo vi /etc/chrony.conf`

3. Specify the time servers that you want to use in your environment.

The chrony file includes the following statements to configure time servers:

```
server 0.centos.pool.ntp.org iburst
server 1.centos.pool.ntp.org iburst
server 2.centos.pool.ntp.org iburst
server 3.centos.pool.ntp.org iburst
```

Enter statements for the servers you want to use. Then delete or comment out the statements that you do not want to use.

Specify a time server via the following command syntax:

```
server My_Time_Server_Name iburst
```

4. Save the file.

5. Restart the chrony service.

Execute the command: `sudo systemctl restart chronyd`

6. Verify that your time is correct.

Execute the `date` command. You should see results similar to:

```
Fri Dec 6 21:09:26 UTC 2019
```

To verify the time has been synchronized, you can execute the command, `timedatectl`. The output should be similar to:

```
Local time: Fri 2019-12-06 21:09:26 UTC
Universal time: Fri 2019-12-06 21:09:26 UTC
RTC time: Fri 2019-12-06 21:09:27
Time zone: UTC (UTC, +0000)
NTP enabled: yes
NTP synchronized: yes
RTC in local TZ: no
DST active: n/a
```

To verify the time, compare the date output with the output from a known UTC time server.

If the output is correct you can assume the system clock is synchronized.

If the output is incorrect, contact your support representative.

(Important) Verifying your MariaDB Version

For its default historical database, Turbonomic currently supports MariaDB version 10.5.16. This support includes comprehensive testing and quality control for Turbonomic usage of the historical database.

If you are running Turbonomic installed as a VM image (OVA or VHD), and using the database that is included in that image installation, then you must use version 10.5.16. If you are updating your version of Turbonomic (instead of installing it for the first time), then you should make sure you are using the correct version of MariaDB with your installation.

This section shows you how to check the version of MariaDB on your VM image installation of Turbonomic. Also, if you have used the update script to update your Turbonomic to version 8.3.5 or later, you can use the steps in this section to update your MariaDB.

Important:

It is a requirement that you run MariaDB version 10.5.16 or later. Turbonomic can operate with other versions of MariaDB. However, it is fully tested to operate with MariaDB version 10.5.16.

Because of a known issue, **you must never use** MariaDB versions 10.5.14, 10.5.15, 10.6.7, 10.7.3, or 10.8.2.

Turbonomic also supports MySQL 5.7.x, deployed as a custom installation.

When you initially installed Turbonomic, that installation included MariaDB running a specific version. As you update your Turbonomic version, the MariaDB version remains the same. The first release of Turbonomic that included MariaDB 10.5.16 is 8.5.6. If you initially installed an earlier version, and you have not explicitly updated your MariaDB to 10.5.16, then you must do it now.

For VM image installations, it is possible to configure the installation to use a remote database (external to the VM). For such deployments, you must manage the database versioning yourself. If you are using a remote MariaDB instance, we recommend that you use version 10.5.16. For a remote MySQL, you should use version 5.7.x.

For installations on a Kubernetes cluster (not deployed as a Turbonomic VM image), if you are using MariaDB we recommend that you use version 10.5.16. You can find a download package at: <https://archive.mariadb.org/mariadb-10.5.16/yum/centos7-amd64>. For MySQL, you should use version 5.7.x. For such deployments, you must manage the database versioning yourself.

Checking your MariaDB Version

To check the version of MariaDB running on your Turbonomic OVA:

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Username: [your_private_password]

2. Check the MariaDB version.

```
mysql -u root --password=my_pwd -e "SHOW VARIABLES LIKE 'version';"
```

The output should be similar to:

Variable_name	Value
version	10.5.16-MariaDB

If the version is lower than 10.5.16-MariaDB, then you must update your database.

If your version is equal to or higher than 10.5.16-MariaDB you should not perform the update steps below.

Updating your MariaDB

If you are using Turbonomic installed as a VM image, and you are using the default MariaDB that was installed with that image, you must run MariaDB version 10.5.16.

Important:

Before you perform these steps, you must have already used the update script to update your Turbonomic to version 8.3.5 or later.

Using the update script to update to 8.3.5 or later installs the necessary MariaDB update scripts. If your current version of Turbonomic is lower than 8.3.5, then update your installed version before executing these steps. For instructions to use the product update script, see [Updating Turbonomic to a New Version](#).

If your MariaDB version is equal to or higher than 10.5.16-MariaDB you should not perform these update steps.

If your current Turbonomic version is earlier than 8.3.5 and you want to update MariaDB but you do *not* want to update Turbonomic, contact your support representative.

To update your MariaDB on your Turbonomic VM:

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Password: [your_private_password]

2. If you perform *offline* updates, ensure the VM is mounted on the Turbonomic update ISO image.

Note:

If you do not allow internet access, then you must perform offline updates of Turbonomic. When you complete the update, the system automatically unmounts the ISO image. To perform the MariaDB update, your Turbonomic instance ***must be mounted*** on the same ISO image that you used to update it to version 8.3.5 or later.

For information about offline updates and mounting the ISO image, see [Offline Update](#).

3. Set up the MariaDB update script.

- a. Log in to the Turbonomic VM.

Use SSH to log in to the Turbonomic VM using the turbo account and password.

- b. Change to the scripts directory.

```
cd /opt/local/bin
```

- c. Get the latest version of the script.

```
curl -O --proxy PROXY_NAME_IP:PORT \  
https://\  
raw.githubusercontent.com/turbonomic/t8c-install/master/bin/mariadbUpgrade.sh
```

Where `--proxy PROXY_NAME_IP:PORT` is an optional specification to execute the download through a proxy.

Note:

If you perform *offline* updates, download the script to your local machine.

- d. Ensure the script is saved on the Turbonomic server at the location:

`/opt/local/bin/mariadbUpgrade.sh`.

Note:

If you perform *offline* updates, use a secure shell session to upload the script from your local machine, to the Turbonomic server.

4. Execute the MariaDB update script.

Before you execute the script, you will need to know the MariaDB password. By default, this password is `vmturbo`.

- a. Navigate to the scripts directory:

```
cd /opt/local/bin
```

- b. Make the script executable.

```
chmod +x mariadbUpgrade.sh
```

- c. Execute the database update script:

```
sudo ./mariadbUpgrade.sh
```

The script updates the version of MariaDB. It also increases size limits for the allowed packets, and buffer and log sizes for the innodb. The script output should include the following (where Total Memory and buffer pool size can vary depending on your VM configuration):

```
=====
Update the mariadb configuration
=====
Total Memory: 128773 MB
Changing Innodb buffer pool size to: 9216 MB
Changing max allowed packets to: 1G
Changing innodb log file size to: 10G
=====
```

5. Verify the updated MariaDB version.

When the script completes, you should be running version 10.5.16. To check the version, execute the following command:

```
mysql -u root --password=my_pwd -e "SHOW VARIABLES LIKE 'version';"
```

The output should be:

```
+-----+-----+
| Variable_name | Value               |
+-----+-----+
| version       | 10.5.16-MariaDB    |
+-----+-----+
```

6. Scale up the Turbonomic platform's pods.

To update the database, the script scales down your platform pods. When it completes, the script displays the following prompt:

```
#####
When confirmed the mariadb has been upgraded and is properly working, run:
kubectl scale deployment --replicas=1 t8c-operator -n turbonomic
#####
```

After you verify that the correct version of MariaDB is running, scale up the platform:

```
kubectl scale deployment --replicas=1 t8c-operator -n turbonomic
```

(Important) Increasing your Database Capacities

For Turbonomic versions 8.0.6 or later, your historical database must provide certain storage size capacities. For MariaDB or MySQL installations, you must ensure your database provides the necessary messaging and logging capacity. (Turbonomic supports MariaDB version 10.5.16 or MySQL 5.7.X for the historical database. For more information, see [Verifying your MariaDB Version.](#))

Note:

If you installed Turbonomic as a VM image (OVA or VHD), the image includes MariaDB for the historic database. Most installations use that instance. However, you can use an external database if you like. In addition, you can install Turbonomic directly to a Kubernetes cluster (instead of installing the VM image), and you can provide your own historical database.

Do I Need to Increase My DB Capacities?

The way you have deployed the historical database in your Turbonomic installation determines whether you must perform this procedure:

For this installation:	DB storage update requirements
<ul style="list-style-type: none"> You installed Turbonomic as a VM image at version 8.0.6 or earlier You use the default MariaDB as your historical database You updated Turbonomic to version 8.0.7 or later You ran the script that updates your MariaDB version (see Verifying your MariaDB Version). 	<p>You do not need to increase your DB capacities. You can skip this procedure.</p> <p>Note: If you are still running MariaDB 10.5.6 or 10.5.9, you must update to 10.5.16. See Verifying your MariaDB Version.</p>
<ul style="list-style-type: none"> You installed Turbonomic as a VM image at version 8.0.6 or earlier You use the default MariaDB as your historical database You have not updated Turbonomic to version 8.0.7 or later You have not run the script that updates your MariaDB version (see Verifying your MariaDB Version). 	<p>You must increase your DB capacities.</p> <p>Note: The simplest way to increase capacities and ensure you are running the correct version of MariaDB is to update Turbonomic to version 8.2.3 or later (see Updating Turbonomic to a New Version). If you want to update your MariaDB without updating Turbonomic, contact your support representative.</p>
<ul style="list-style-type: none"> You installed Turbonomic as a VM image You use an <i>external</i> MariaDB or MySQL as your historical database 	<p>You must increase your DB capacities.</p>
<ul style="list-style-type: none"> You installed Turbonomic directly on a Kubernetes cluster (not deployed as the Turbonomic VM image) You use MariaDB or MySQL as your historical database 	<p>You must increase your DB capacities.</p>

Checking you Current DB Capacities

Before you update your DB capacities, check to make sure they need to be increased. Open an SSH terminal session that can administer your database, and execute the following commands:

- Check the size for `max_allowed_packet`.

```
mysql -u root --password=vmturbo -e "SHOW VARIABLES LIKE 'max_allowed_packet';"
```

You should see output similar to:

```
+-----+-----+
| max_allowed_packet | {PacketSize} |
+-----+-----+
```

Where **{PacketSize}** is your current value. If it is greater than or equal to 1073741824, you do not need to increase this capacity.

- Check the size for `innodb_log_file_size`.

```
mysql -u root --password=vmturbo -e "SHOW VARIABLES LIKE 'innodb_log_file_size';"
```

You should see output similar to:

```
+-----+-----+
| innodb_log_file_size | {LogSize} |
+-----+-----+
```

Where **{LogSize}** is your current value. If it is greater than or equal to 10737418240 (10 times the max allowed packet size), you do not need to increase this capacity.

Configuring the Capacities

To configure your DB capacities:

1. Edit your `server.cnf` file to set the following server system variables:

- `max_allowed_packet = 1G`
- `innodb_log_file_size = 10G`

To make these settings, open the `server.cnf` file in an editor, change the values for these system variables, and then save your changes.

By default, you can find the configuration file at this location:

```
/etc/my.cnf.d/server.cnf
```

2. Restart your DB instance.

Execute the command:

- For MariaDB:

```
sudo systemctl restart mariadb
```

- For MySQL:

```
sudo systemctl restart mysqld
```

3. Verify the system capacities.

After the database restarts, execute the following commands:

- `mysql -u root --password=vmturbo -e "SHOW VARIABLES LIKE 'max_allowed_packet';"`

You should see output similar to:

```
+-----+-----+
| Variable_name | Value       |
+-----+-----+
| max_allowed_packet | 1073741824 |
+-----+-----+
```

- `mysql -u root --password=vmturbo -e "SHOW VARIABLES LIKE 'innodb_log_file_size';"`

You should see output similar to:

```
+-----+-----+
| Variable_name | Value       |
+-----+-----+
| innodb_log_file_size | 10737418240 |
+-----+-----+
```

Increasing Available Disk Space

A standard installation of Turbonomic on a VM image includes a MariaDB database server for historical data. If you enable Embedded Reports, the platform also uses TimescaleDB Postgres database to manage the reports data. For various reasons, you might find that the default storage capacity for your database services is not sufficient. In that case, you need to increase the available storage capacity.

A common reason to increase this capacity is to accommodate estimated needs for Embedded Reports. The storage requirements for Embedded Reports can change over time as your environment changes, or as you increase the number of targets you configure your Turbonomic installation.

For information about estimating Embedded Reports requirements, see [Embedded Reports Storage Requirement Estimates](#).

A summary of the steps you will perform is:

- Add a new disk to the VM
- Rescan the scsi devices
- Create a new LVM partition
- Create a physical volume (pv)
- Add the pv to the existing volume group (vg)
- Extend the logical volume (lv)
- Extend the file system to use the new lv
- To increase storage for Embedded Reports, increase the XFS quota

To increase space for MariaDB, you do not need to perform this step.

Logical Volume Management for Turbonomic Storage

The platform uses Logical Volume Management (LVM) to manage the VM disks. To increase database storage, you should add a new disk to the VM, and then use it to extend the LVM logical volume, `/dev/turbo/var_lib_mysql`. This logical volume serves both the historical database and the Embedded Reports database.



Increasing Storage – Procedure

To increase the storage space available to your databases:

1. Add a new disk to the VM.

Use the steps for your VM datacenter to add a new disk to the VM. Turbonomic installs as a VMware or a Hyper-V VM. Refer to the documentation for your hypervisor for the steps to add a new disk.

2. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Password: [your_private_password]

3. Rescan the scsi devices.

To make sure the new disk is available, rescan the scsi devices and then list your block devices.

To scan the devices, execute:

```
echo "- - -" > /sys/class/scsi_disk//0:0:0:0/device/rescan
```

To check for the new disk, execute:

```
lsblk
```

The new disk should appear with a name similar to `/dev/sdc`. If you don't see the new disk, try this alternative to force a rescan:

- Check the number of scsi host devices that are on your VM:

```
ls /sys/class/scsi_host
```

You should see a list of devices, such as `host0`, `host1`, `host2... hostn`

- Scan each device

For each device execute the command (where **<hostn>** is a numbered host device such as `host0` or `host1`):

```
echo "- - -" > /sys/class/scsi_host/host0/scan
```

- List the block devices

Execute `lsblk` again to list the block devices.

4. Create a new LVM partition.

Assuming the new disk is named `/dev/sdc1`, execute the command:

```
cfdisk /dev/sdc1
```

Then execute the operations:

- `new`
- `primary`
- `confirm size`
- `change type to 8E`
- `write`
- `quit`

5. Create the Physical Volume (pv).

Assuming the new disk is named `/dev/sdc1`, execute the command:

```
pvcreate /dev/sdc1
```

6. Add the new pv to the existing Volume Group.

Assuming the new disk is named `/dev/sdc1`, execute the command:

```
vgextend /dev/turbo /dev/sdc1
```

7. Extend the Logical Volume (lv) to use the free space in the new pv.

First list the physical extents (PE) that are available. Execute the command:

```
vgdisplay
```

You should see results similar to:

```
Free PE / Size      128000 / 500.00 GiB
```

In this example, 128000 is the amount to extend the lv. For this example, execute the command:

```
lvextend -l +128000 /dev/turbo/var_lib_mysql
```

8. Extend the XFS file system to use all the current lv space.

Before you extend the XFS, view the free disk space and record the number. To verify that you have increased the available space, you will compare this value to the free space after you have extended XFS. Execute the command:

```
df -h
```

Then extend the XFS capacity:

```
xfs_growfs /dev/turbo/var_lib_mysql
```

Then list the updated free disk space and compare it to your original number:

```
df -h
```

9. If you are increasing capacity for Embedded Reports, extend the XFS quota for the TimescaleDB.

To increase space for MariaDB, you do not need to perform this step.

To increase capacity for the Timescale DB, you need to increase the quota for that process by the amount you want. The quota name is Postgresql.

For example, assume you added a 400 GB volume, and the current Postgresql quota is 400 GB. In that case, you could increase the quota to 800 GB. Following this example, execute the command:

```
xfs_quota -x -c 'limit -p bhard=800g Postgresql' /var/lib/dbs
```

To see the current quotas set for /var/lib/dbs, execute the command:

```
xfs_quota -xc 'report -pbih' /var/lib/dbs
```

(Optional) Enforcing Secure Access Via LDAP

If your company policy requires secure access, you can use a certificate with your LDAP service to set up secure access for your users. For example, you can configure Active Directory (AD) accounts to manage *External Authentication* for users or user groups. The user interface to enable AD includes a **Secure** option, which enforces certificate-based security. For more information, see "Managing User Accounts" in the *Turbonomic User Guide*.

If your LDAP service uses a Certificate Authority (CA), then the certificate signed by that CA should support this feature as it is. Simply turn on the **Secure** option when you are setting up your AD connection.

If your LDAP service uses a self-signed certificate, then you must install that certificate on the Turbonomic authorization pod. The steps you will perform include:

- Get the certificate from your LDAP server
- Import the certificate to the platform's TrustStore
- Add the certificate to the Turbonomic platform's authorization pod
- Enable the TrustStore in the Turbonomic platform's Operator chart

The procedure to install the certificate is different depending on the version of Turbonomic that you initially installed:

- If you *initially installed* Turbonomic 8.1.5 or later, see [8.1.5 or Later: Installing a Self-signed Certificate](#)
- If you *initially installed* Turbonomic 8.1.4 or earlier, see [8.1.4 or Earlier: Installing a Self-signed Certificate](#).

8.1.5 or Later: Installing a Self-signed Certificate

This section describes how to set up secure access from an LDAP server, to a Turbonomic platform that was installed as version 8.1.5 or later. It assumes you have authorization to get a certificate from the LDAP server, as well as admin authority on the Turbonomic platform.

To set up secure access:

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Password: [your_private_password]

2. Download your LDAP Server certificate to the Turbonomic instance.

Acquire a certificate from your LDAP administrator, and download it to the Turbonomic platform. For example, you can download it to the file `/tmp/ldapserver.crt`:

3. Import the `.crt` file to the Turbonomic TrustStore.

This step modifies the `cacerts` file on the Turbonomic platform.

Note:

To import a certificate to the Turbonomic TrustStore, you must use the `keytool` utility. To install this utility, execute the command:

```
sudo yum install java-1.8.0-openjdk
```

This installs the utility in `/usr/bin/keytool`.

If an alias for an LDAP certificate already exists, delete that certificate. For example, assuming the alias `ldapcert1`, execute the following command:

```
keytool -delete -alias ldapcert1 -keystore cacerts -storepass changeit
```

Then use the following command to import your new certificate to the TrustStore:

```
keytool -import -alias ldapcert1 -file /tmp/ldapserver.crt -keystore cacerts \
  -deststoretype jks -storepass changeit -noprompt
```

4. Create an auth secret from the `cacerts` file.

```
base64 cacerts > auth-secrets.yaml
```

5. Open the secrets file for editing.

```
vi auth-secrets.yaml
```

6. Edit the file to make it a valid yaml file.

- a. Indent every line of the certificate by four spaces.

When you created the file, you concatenated the contents of the certificate. The first step is to indent the certificate by four spaces. For example, in a `vi` editor, execute the following command:

```
:%s/^/    /g
```

- b. Add data fields to the secrets file.

Add the following text to the top of the file:

```
apiVersion: v1
kind: Secret
metadata:
  name: auth-secret
data:
  cacerts: |
```

c. Save your changes.

The completed file should be similar to:

```
apiVersion: v1
kind: Secret
metadata:
  name: auth-secret
data:
  cacerts: |
/u3+7QAAAAIAAAAABAAAAAGAFY2VydDEAAAF5H21EigAFWC41MDkAAAYQMIIGDDCCBPSgAwIBAgIT
HAAAAARHIFJdLbG90sAAAAAABETANBgkqhkiG9w0BAQUFAADBcMRMwEQYKCZImiZPyLGBGRYDY29t
MRcwFQYKCZImiZPyLGBGRYHdm10dXJibzEUMBIGCgMSJomT8ixkArkWBGNvcnAxFjAUBGNVBAMT
DWNvcnAtREVMTDEtQ0EwHhcNMjEwNDA4MDM00TEyWhcNMjEwNDA4MDM00TEyWjAhMR8wHQYDVQQD
ExZkZwxsMS5jb3JwLnZtdHVyYm8uY29tMIIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEA
sCXuh2MTIrFERYU/aKgdbgyjLeZnuwF6nmZveZUhdAJDpflHJlzhwfyYRTGfSSusVo4polJS4WqPZ
T3Zk8f2IaX04RpfPQErq5N3uY/BxFkATWLMdiQuSd0Di798k2diYXAXvzMfmIkBBYJta9oztum
uXyh/42dX0GznQ5fFuxosgAksZ6CnXGDKrTB1b0bHpST1z1PdG+fJ+f9Tq7Iff0YdVbuedFTwsik
Z0JgDCIRrmmS0JphiHdBqJ6ZLdbSeEzBIbboiQs81pAELw7V0ZZUfKV6y8+zMTACGwpVPJSFv7LX
RLw1TWcqHXA0mroe2WcU8KJE6XZTbXp7z7dzWIDAQABo4IDADCCAvwwLwYJKwYBBAGCNxQCBCIE
IABEAG8AbQBhAgKAbgBDAG8AbgB0AHIAbwBsAGwAZQByMB0GA1UdJQQWMBQGCCsGAQUFBwMCBggr
BgEFBQcDATAOBgNVHQ8BAf8EBAMCBaAweAYJKoZIhvcNAQkPBGSwaTA0BggqhkiG9w0DAGICAIAw
DgYIKoZIhvcNAwQCAGCAMAsGCWCGSAFlAwQBKjALBg1ghkgBZQMEAS0wCwYJYIZIAWUDBAECMAAG
CwCGSAFlAwQBBTAHBGUrdgMCBzAKBggqhkiG9w0DBzBCBgNVHREEOzA5oB8GCSsGAQQBgjcZAaAS
BBDswj1Hut/nQZ0uK2aUg1GbgHkZkZwxsMS5jb3JwLnZtdHVyYm8uY29tMB0GA1UdDgQWBBER6M7Hb
BiirpjiXQ3PXXScB8LkmRDAfBgNVHSMEGDAWgBRjs9l3e17SuKUDM1rHHRhBkENgaDCB0QYDVROf
BIHJMIHGMIHDoIHAAoIG9hoG6bGRhcDovLy9DTj1jb3JwLURFTExwLUNBLENOPWR1bGwxLENOPUNE
UCxDtj1QdWJsaWM1MjBLZXklMjBTZkZ2aWN1cyxDTj1TZkZ2aWN1cyxDTj1Db25maWd1cmF0aW9u
LERDPWNvcnAsREM9dm10dXJibyxEQz1jb20/Y2VydG1maWwNhdGVScXZvY2F0aW9uTG1zdD9iYXN1
P29iamVjdENsYXNzPWNSTERpc3RyaWJ1dGlvlb1BvaW50MIHBBggrBgEFBQcBAQSBujCBtZCBtAYI
KwYBBQUHMAKGGadsZGFwOi8vL0NOPWNvcnAtREVMTDEtQ0E0sQ049QU1BLENOPVB1YmXpYyUyMET1
eSUyMFN1cnZpY2VzLENOPVN1cnZpY2VzLENOPUNvbmZpZ3VyYXRpb24sREM9Y29ycCxEQz12bXR1
cmJvLERDPWNvbt9jQU1cnRpZml1YXRlP2Jhc2U/b2JqZWNoQ2xhc3M9Y2VydG1maWwNhdGlvbKf1
dGhvcml0eTANBgkqhkiG9w0BAQUFAAOCAQEADP6OYLONkZ2j6gaBdfdoIJtvn1g1qXTsRrtFuUCF
C9mUxL0G5Tudr0VlyEnLH2wtj10CGsIi54+aPGYiElXijThEe1WTHa02hk1RLdNrM8KxUp3tUNb/
cP4d+EYt297wVWgxp19MStiND8+7M2+65daoEu5IOLtq41C7Y1CSXay19N5HdiGBHV5L07PTZ261
qDzShSb0ZwtG7++5VqkveVEIfs3hUYdaItz0Zu6sym90aUcvn5wohV1GPPqGDvVCg5Kf50hsZfmy
ltNlaqiiqLMnYVMA93CkPFFjoP9gmGFJky0yTfh6G8HuqbI7guddDsUqMQTT3uv3EBwSYeIm0ya7
Zye5C4NnsAFnx8k0wXdsVERC
```

7. Apply this secrets file to the platform environment.

```
kubectl apply -f auth-secrets.yaml
```

8. Update the platform's Operator Chart to use the cacerts certificate that you created in the secrets file.

a. Open the chart file for editing.

Open the file, `/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml`.

b. Add the certification secret as an authorization spec for the component options.

In the chart file, find the `spec:` section. Within that section, find the `auth:` subsection.

This should be the second subsection in `spec:`, after `global:`. If there is no `auth:` subsection, you can add it to `spec:`.

c. Add the certification secret to the file:

You will add the secret's path to a `javaComponentOptions:` statement within the `auth:` subsection. Add the path as a `-D` option. The `auth:` subsection should be similar to the following, with `auth` indented by two spaces and `javaComponentOptions` indented by four spaces:

```
# Pass in the JAVA_OPTS to the auth POD to set up additional options such as
# a trustStore for AD Certificate(s) for LDAPS (Secure LDAP)
auth:
  javaComponentOptions: "-Djavax.net.ssl.trustStore=/home/turbonomic/data/helper_dir/
cacerts"
```

d. Apply your Operator Chart changes to the Turbonomic platform.

Execute the following command:

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

This restarts the authorization component so it can use the new setting.

8.1.4 or Earlier: Installing a Self-signed Certificate

This section describes how to set up secure access from an LDAP server, to a Turbonomic platform that was installed as version 8.1.4 or earlier. It assumes you have authorization to get a certificate from the LDAP server, as well as admin authority on the Turbonomic platform.

To set up secure access:

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Password: [your_private_password]

2. Download your LDAP Server certificate to the Turbonomic instance.

Acquire a certificate from your LDAP administrator, and download it to the Turbonomic platform. For example, you can download it to the file `/tmp/ldapserver.pem`:

3. Import the `.pem` file to the Turbonomic TrustStore.

This step modifies the `cacerts` file on the Turbonomic platform.

Note:

To import a certificate to the Turbonomic TrustStore, you must use the `keytool` utility. To install this utility, execute the command:

```
sudo yum install java-1.8.0-openjdk
```

This installs the utility in `/usr/bin/keytool`.

If an alias for an LDAP certificate already exists, delete that certificate. For example, assuming the alias `ldapcert1`, execute the following command:

```
keytool -delete -alias ldapcert1 -keystore cacerts -storepass changeit
```

Then use the following command to import your new certificate to the TrustStore:

```
keytool -import -alias ldapcert1 -file /tmp/ldapserver.pem -keystore cacerts \
-deststoretype jks -storepass changeit -noprompt
```

4. Add the TrustStore to the Turbonomic authorization pod.

Execute the following command to copy the `cacerts` file into the authorization pod:

```
kubectl cp cacerts $auth_pod:/home/turbonomic/data/cacerts
```

5. Update the platform's Operator Chart to use the TrustStore.

- a. Open the chart file for editing.

Open the file, `/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml`.

- b. Add the TrustStore as an authorization spec for the component options.

In the chart file, find the `spec :` section. Within that section, find the `auth :` subsection.

This should be the second subsection in `spec :`, after `global :`. If there is no `auth :` subsection, you can add it to `spec :`.

- c. Add the TrustStore to the `auth :` subsection.

You will add the TrustStore path to a `javaComponentOptions :` statement within the `auth :` subsection. Add the path as a `-D` option. Use the same path that you copied the `cacerts` file to in the Turbonomic authorization pod. In the above example, you copied it to `$auth_pod:/home/turbonomic/data/cacerts`.

Following the above example, the `auth :` subsection should be similar to the following, with `auth` indented by two spaces and `javaComponentOptions` indented by four spaces:

```
# Pass in the JAVA_OPTS to the auth POD to set up additional options such as
# a trustStore for AD Certificate(s) for LDAPS (Secure LDAP)
auth:
  javaComponentOptions: "-Djavax.net.ssl.trustStore=/home/turbonomic/data/cacerts"
```

- d. Save the `charts_v1alpha1_x1_cr.yaml` file.

6. Apply your Operator Chart changes to the Turbonomic platform.

Execute the following command:

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

This restarts the authorization component so it can use the new setting. As the component restarts, the `rsyslog` output should include the following Message:

```
-Djavax.net.ssl.trustStore=/home/turbonomic/data/cacerts
```

(Optional) Enforcing Secure Access Via Trusted Certificate

If your company policy requires SSL connections via trusted certificate, Turbonomic enables you to install a trusted certificate from a known certificate authority.

Requesting a Certificate

The first step is to acquire a certificate. The following steps describe how to generate a certificate request.

1. Open a shell terminal session.

Open an SSH terminal session on your Turbonomic instance. Log in as `turbo`, and use the password that you created for the administration account in the installation steps above. For information, see the installation step, [Set up the Turbonomic System Administrator account](#).

2. Change to the directory where you want to store the private key file.

If your shell session is on your Turbonomic instance, you should use the `/opt/turbonomic` directory:

```
cd /opt/turbonomic
```

3. Create and save the private key file.

Execute the command to create a private key file.

For this example, the private key file is named `myPrivate.key`

```
openssl genrsa -out myPrivate.key 2048
```

You will need this file later. If you are in a session on your Turbonomic instance, you might want to copy the file to your local machine.

4. Create a file to contain the information that will generate the signed certificate request (CSR).

```
vi certsignreq.cfg
```

5. Add the request data to the certsignreq.cfg file.

In the file, insert the following code. For any fields marked by angle brackets (for example <city>), provide the indicated value. For example, your country, city, company, etc.

```
[req]
ts = 2048
prompt = no
default_md = sha256
req_extensions = req_ext
distinguished_name = dn

[dn]
C=<country, 2 letter code>
L=<city>
O=<company>
OU=<organizational unit name>
CN=<FQDN>
emailAddress=<email address>

[req_ext]
subjectAltName = @alt_names

[alt_names]
DNS.1 = <FQDN>
DNS.2 = <server's short name>
DNS.3 = <server's IP address>
```

Note:

For the CN field, specify the fully-qualified domain name of the Turbonomic instance.

Alternate names are other ways to access the Turbonomic instance. In the [alt_names] section, the value for the DNS.1 field is required. For DNS.1, specify the fully-qualified domain name of the Turbonomic instance. Values for the DNS.2 and DNS.3 are optional. You can add more DNS.<n> fields if needed.

For example:



```
root@turbonomic:/etc/pki/tls/private

ts = 2048
prompt = no
default_md = sha256
req_extensions = req_ext
distinguished_name = dn

[dn]
C=US
ST=New York
L=White Plains
O=Turbonomic
OU=Educational Services
CN=demo.turbonomic.com
emailAddress= <first.lastname> @turbonomic.com

[req_ext]
subjectAltName = @alt_names

[alt_names]
DNS.1 = demo.turbonomic.com
DNS.2 = demo
DNS.3 = my.ip.add.ress
```

6. Write and quit the file.

Press **esc**, type `:wq!`, and press **Enter**.

7. Generate the certificate request file.

In this example, we name the file `myRequest.csr`.

Execute the command:

```
openssl req -new -sha256 -nodes -out myRequest.csr -key \
myPrivate.key -config certsreq.cfg
```

8. Send the generated request file to your certificate authority.

If you generated the file on your Turbonomic instance, you should transfer the file to your local machine. The path to the certificate request file on your remote machine is `/opt/turbonomic/myRequest.csr`.

Your certificate authority will use this file to create the certificate for you.

If your certificate authority gives you an encoding choice between DER and Base 64, choose **Base 64**.

9. When you receive the certificate, save it to disk.

If you did not receive the certificate encoded in Base 64, you must convert it from DER to Base 64. Execute the following command, assuming the certificate is named `MyCertificate.crt`:

```
openssl x509 -inform der -in MyCertificate.der -out MyCertificate.crt
```

Installing the Signed Certificate in Turbonomic

Once you have obtained the signed certificate, you can install it on your Turbonomic instance. You will use the private key and certificate files you obtained when requesting the signed certificate:

- `myPrivate.key`
- `MyCertificate.crt`

To install the signed certificate:

1. Open an SSH terminal session on your Turbonomic instance.
2. Add the key and certificate data to your Turbonomic `charts.yaml` file.

Open the file: `/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml`

Find the section for `global` parameters. Under the `global` parameters, create the `ingress:secrets` section, and then create entries for `certificate`, `key`, and `name`.

Your `global` parameters should be similar to the following:

```
global:
  ingress:
    secrets:
      - certificate: |
          -----BEGIN CERTIFICATE-----
          SAMPLE PUBLIC KEY
          -----END CERTIFICATE-----
      key: |
          -----BEGIN RSA PRIVATE KEY-----
          SAMPLE PRIVATE KEY
          -----END RSA PRIVATE KEY-----
      name: nginx-ingressgateway-certs
```

For the fields you added:

- `certificate`: This field holds the content of your `MyCertificate.crt` file. Open that file to copy its contents and paste them here.
- `key`: This field holds the content of your `myPrivate.key` file. Open that file to copy its contents and paste them here.

- **name**: This field is required, and the name must be `nginx-ingressgateway-certs`.

3. Apply the changes you made to the CR file.

Execute the command:

```
kubectl apply -f \
  kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

4. Restart the nginx pod.

To require a certificate for HTTPS access, you must restart the nginx pod:

a. Get the full name of the pod.

Execute the command `kubectl get pods -n turbonomic`. In the output, look for the entry for nginx. You should find an entry similar to:

```
nginx-5b775f498-sm2mm          1/1      Running    0
```

b. Restart the pod.

Execute the following command, where **<UID>** is the generated ID for the pod instance:

```
kubectl delete pod nginx-<UID>
```

This should restart the nginx pod. After restart, Turbonomic will then require a certificate for HTTPS access.

(Optional) Enabling Secure Access for Probes

If your targets require SSL connections via trusted certificate, Turbonomic enables you to install a trusted certificate on the associated probe component.

The Turbonomic platform includes a number of probe components that it uses to connect to targets and discover their data. This procedure assumes setup for one component, the *Dynatrace* probe. You can use the same steps for other probes, providing a different Kubernetes Secret Name for each.

Note:

To configure SSL communication for multiple probes, you must get a unique certificate for each one.

To install a certificate on a probe component, you must know the Kubernetes secret name for the given probe. This table lists the probes that you can configure, plus their secret names. If you must configure secure access for any probes not listed here, please contact your support representative.

Probe:	K8s Secret Name:
mediation-awsbilling mediation-aws mediation-awscost mediation-awslambda	aws
mediation-appinsights	appinsights
mediation-newrelic	newrelic
mediation-azuresp mediation-azure mediation-azurevolumes	azure

Probe:	K8s Secret Name:
mediation-azurecost	
mediation-azureea	azureea
mediation-dynatrace	dynatrace

Installing the Signed Certificate on the Probe Component

This procedure assumes you already have a valid `.crt` file. For steps to get a signed certificate, see [Requesting a Certificate](#). However, instead of generating the certificate on your Turbonomic instance, you should generate it on your local machine.

Once you have obtained the signed certificate, you can install it on your probe instance. You will use the certificate file you obtained when requesting the signed certificate:

```
MyCertificate.crt
```

To install the signed certificate on a probe:

1. Copy the certificate from your local machine to the Turbonomic instance.

Use SCP to copy the `MyCertificate.crt` from your local machine to the `/tmp` directory on the instance. Once you have done this, you can use `kubectl` to transfer the certificate to the probe component.

2. Open an SSH terminal session on your Turbonomic instance, using the `turbo` user account.
3. Copy the certificate file to the probe component.

First, get the ID for the pod that runs the probe. To get the ID, execute the command:

```
kubectl get pod
```

This lists the pods running in the Turbonomic platform, including their IDs. Record the ID of the pod you want to configure.

To copy the certificate, execute the following command, where **<Probe-Pod-Id>** is the ID you recorded:

```
kubectl cp /tmp/MyCertificate.crt <Probe-Pod-Id>:/tmp
```

4. Copy the keystore `cacerts` file to the component's `/tmp` directory.

Use these commands to open a bash session on the pod and copy the file:

- `kubectl exec -ti <Probe-Pod-Id> bash`
- `cp /etc/pki/ca-trust/extracted/java/cacerts /tmp`

5. Import the certificate into the pod's keystore.

As part of this step, you will ensure that the certificate is in Base64 format. While still in the bash session on your probe component, execute the following commands:

- `chmod 775 /tmp/cacerts`
- `keytool -import -alias MyCertificate.crt -file \`
`/tmp/ca.crt -keystore /tmp/cacerts -deststoretype jks \`
`-storepass changeit -no-prompt`

Where **MyCertificate.crt** is the name of the certificate that you acquired.

- `base64 /tmp/cacerts > base64.txt`

6. Create the yaml file to contain the certificate data.

You will create a yaml file using the K8s Secret Name for the probe, with the following naming convention:

```
/tmp/<Secret_Name>-secrets.yaml
```

For example, assume you are enabling SSL for the Dynatrace probe. In that case, the secret name is `dynatrace`, and you would create the yaml file:

```
/tmp/dynatrace-secrets.yaml
```

a. While still in the bash session on the probe component, open the yaml file in a vi editor session:

```
vi /tmp/<Secret_Name>-secrets.yaml
```

b. Then add the following content to the file:

```
apiVersion: v1
kind: Secret
metadata:
  name: dynatrace
data:
  cacerts: |
    xxxxxxxxxxxxxxxxxxxxxxxxxxxx
    xxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

In the `cacerts` section, replace the `xxx` characters with the `base64.txt` data that you generated.

c. Align the base64 data to the yaml format.

Press `ESC` to exit the edit mode you were in to add the content to the file. Then type `:` to enter the command mode. For the command, type the following, where the whitespace token is four space characters:

```
7,$s/^/    /
```

Press `RETURN` to execute the command. Then save and exit the vi editor.

7. Exit your session on the probe component.

You now have a yaml file on the probe component that configures a certificate for communications from that probe. You must leave the session on the probe so you can apply the yaml to the Turbonomic platform.

To leave the component session and return to your session on the Turbonomic VM, type `exit` in the shell.

8. Apply the yaml file to the Turbonomic platform.

To apply the yaml file to your platform, you copy it from the probe component to the platform, and then you apply it.

To copy the file from the probe component, you must know the pod ID. To get the ID, execute the command `kubectl get pod`, and record the ID of the pod you have just configured. Then execute the following commands, where **<Probe-Pod-Id>** is the ID you recorded, and :

- ```
kubectl cp <Probe-Pod-Id>:/tmp/<Secret_Name>-secrets.yaml \
/tmp/<Secret_Name>-secrets.yaml
```
- ```
kubectl apply -f /tmp/<Secret_Name>-secrets.yaml
```

9. For each probe that you configure with a SSL certificate, add an entry in the `chart_v1alpha1_cl_cr.yaml` file.

- a. With a shell session running on the Turbonomic platform, open the following file in a text editor:

```
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

- b. Search the file for the entry for the probe that you are configuring. Use the probe names listed in the table above. For example, if you are configuring the Dynatrace probe, find the entry for mediation-dynatrace.
- c. Underneath the probe entry, add the following entry for javaComponentOptions:

```
javaComponentOptions: -Djavax.net.ssl.trustStore=/etc/targets/cacerts
-Dorg.eclipse.jetty.websocket.jsr356.ssl-trust-all=true
-DLog4jContextSelector=com.vmturbo.mediation.common.context.ThreadGroupPrefixContextSelect
or
```

For example, if you are configuring the Dynatrace probe, the entry should be similar to:

```
mediation-dynatrace:
  javaComponentOptions: -Djavax.net.ssl.trustStore=/etc/targets/cacerts
-Dorg.eclipse.jetty.websocket.jsr356.ssl-trust-all=true
-DLog4jContextSelector=com.vmturbo.mediation.common.context.ThreadGroupPrefixContextSelect
or
  resources:
    limits:
      memory: 2Gi
```

- d. Save and exit the chart_v1alpha1_cl_cr.yaml file.
- e. Apply the changed file to your Turbonomic platform.

Execute the command:

```
kubectl apply -f /opt/turbonomic/kubernetes/operator/deploy/crds/
charts_v1alpha1_xl_cr.yaml
```

(Optional) Modifying the Certificates for Cluster Manager

For installations behind a firewall, to upload diagnostics from the clustermgr component, you must modify its certificates. If you decide to modify these certificates, you must be running Turbonomic version 8.1.5 or later.

These steps to modify the certificates on clustermgr assume you have already generated the certificates that you want to add to the cluster manager.

1. Open an SSH terminal session on your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username:

```
turbo
```

- Password:

```
[your_private_password]
```

2. Get the full name of the clustermgr pod.

Execute the command:

```
kubectl get pods -n turbonomic | grep clustermgr
```

The result should be similar to:

```
clustermgr-5f487f58f-tf84b    0/1    Running    52        2d4h
```

In this example, `clustermgr-5f487f58f-tf84b` is the full name of the pod, and `5f487f58f-tf84b` is the `POD_ID`.

3. Save a copy of the pod's current `ca-bundle.crt` file to `/tmp`.

Execute the following command, where `<POD_ID>` is the ID you get from the pod's full name.

```
kubectl cp \
clustermgr-<POD_ID>:etc/pki/ca-trust/extracted/pem/tls-ca-bundle.pem \
/tmp/ca-bundle.crt
```

4. Add your certificates to the bundle.

Repeat this command for each certificate, where `<MY_CERT>` is your certificate file.

```
cat <MY_CERT> >> /tmp/ca-bundle.crt
```

5. Create a Kubernetes secret for the modified certificates.

```
kubectl create secret generic clustermgr-secret --from-file=/tmp/ca-bundle.crt
```

6. Open the `cr.yaml` file for editing.

For example:

```
vi /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

7. Modify the `cr.yaml` file to use this secret.

Add the following to the file:

```
clustermgr:
  env:
    - name: component_type
      value: clustermgr
    - name: instance_id
      valueFrom:
        fieldRef:
          fieldPath: metadata.name
    - name: instance_ip
      valueFrom:
        fieldRef:
          fieldPath: status.podIP
    - name: serverHttpPort
      value: "8080"
    - name: kafkaServers
      value: kafka:9092
    - name: kafkaNamespace
      valueFrom:
        fieldRef:
          apiVersion: v1
          fieldPath: metadata.namespace
    - name: CURL_CA_BUNDLE
      value: /home/turbonomic/data/ca-bundle.crt
```

8. Save your changes and apply the `cr.yaml` file.

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

If you watch the log with `grep ^clustermgr`, then you should see the appropriate curl command execute whenever you send diagnostics.

You can also check the `.crt` file in the cluster manager pod via the following commands, where `<POD_ID>` is the ID you got from the pod's full name:

```
kubectl exec -it clustermgr-<POD_ID> bash
vi /home/turbonomic/data/ca-bundle.crt
```

(Optional) Integrating Turbonomic DataCloud

Turbonomic Data Cloud is a unique data service focused on streaming data from the Turbonomic platform to display it visually. Data Cloud integrates directly with your Turbonomic platform to pull data about your Applications, Container Orchestration, Hypervisors, Storage, and Cloud Service Providers. It gives you the means to show and share how Turbonomic is currently assuring application performance as well as helping you find areas to drive further automation.

To integrate DataCloud, you configure a Turbonomic collector to run through your service account. To do this, you will:

- Generate a Service Account key

You generate this data from the DataCloud user interface.

- Install the Turbonomic Collector

You install the Collector on your Turbonomic instance.

Prerequisites

Before you begin, make sure your environment meets the requirements:

- Turbonomic version 7.22.6 or later
- Firewall and/or proxy access from the Turbonomic platform, out to `https://datacloud.turbonomic.io`
- Access to the image for the Turbonomic Collector container

You can access this image via these routes:

- Offline, using the Turbonomic ISO, attached to the Turbonomic VM.

For an example of using the ISO in an offline update, see [Offline Update](#).

- Online, accessing Docker Hub services to get the image

You will need firewall and/or proxy access to `https://hub.docker.com`. For a list of Docker Hub endpoints you need to access, see [Online Update](#).

- Your Project ID

This is the identifier of your Data Cloud project that was configured when you signed up for Data Cloud. To find the project ID, log into your project and review the URL that appears in your browser's address bar. For example, assume your project ID is **MyProject**. In that case, the URL in the address bar will be similar to:

```
https://datacloud.turbonomic.io/?projectId=MyProject
```

Generating a Service Account Key

You must generate a key for your account, and save it as a file on the Turbonomic instance.

1. Log into the DataCloud user interface.
2. Generate the key data.

In the Navigation Menu, choose **Data Sources**, and display the **Turbonomic** tab. Then click **Generate Key**.

DataCloud generates the key data and displays it on the screen. You will copy this data to paste it in a file on your Turbonomic instance. (Note that DataCloud also downloads the key data as a JSON file to your local computer.)

Note:

Keep this data safe, and do not share it. If you download the generated JSON file, you should also keep the file safe and not share it.

3. Create a Key Data file on your Turbonomic instance.

We recommend that you store the file on the instance in the `/tmp` directory:

- a. Start an SSH session on the Turbonomic instance.
- b. Change to the `/tmp` directory.
- c. Use a text editor to open a file for editing.
Name the file `DataCloudKey.json`.
- d. Copy the key data from the DataCloud user interface, and paste it into the file you are editing.
- e. Save the file.

Installing the Turbonomic Collector

To install the collector, you will create a Kubernetes secret to store the DataCloud key data, modify the configuration for the Turbonomic cluster, and then apply your changes.

1. If you have not already, start an SSH session on your Turbonomic instance.
2. Create a Kubernetes secret for your DataCloud key.

Execute the following command, where `/tmp/DataCloudKey.json` is the path to the DataCloud key file that you created on the Turbonomic instance:

```
kubectl create secret generic datacloud-collector-key \
  --from-file=credentials.json="/tmp/DataCloudKey.json"
```

3. Edit the Turbonomic `cr.yaml` file.

Open the following file for editing in a text editor:

```
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

In the `global:` section, add the following, where **<ProjectID>** is the project ID that you recorded for the prerequisites above:

```
datacloud:
  enabled: true
  credentials:
    project_id: <ProjectID>
    type: service_account
    secret_name: datacloud-collector-key
```

Note that the `datacloud:` entry (the first line of this listing) must be indented by two spaces. The indents in yaml files are significant.

4. Apply your changes.

Execute the command:

```
kubectl apply \
-f /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml \
-n turbonomic
```

(Optional) Enabling Embedded Reports

Embedded reporting runs in its own component, as part of the Turbonomic platform. This architecture enhances performance and reduces storage requirements. When you enable Embedded Reports, you can navigate to a set of pre-built dashboards that chart multiple environment details. Dashboards and charts are powered by the Grafana observability platform. With Grafana, it's easy to navigate the existing dashboards, and to make your own charts and dashboards with no coding required.

Note:

Embedded Reports use the TimescaleDB service, a time-series SQL database that provides fast analytics and scalability on a proven storage engine. These instructions are for the default configuration of TimescaleDB. As an alternative, you can configure an external deployment of TimescaleDB, and use that to manage your Embedded Reports data. For more information, see [Configuring an External TimescaleDB](#).

The method you use to enable embedded reports depends on the version status of your Turbonomic instance, as follows:

- [Script Interface](#)

You have installed Turbonomic version 8.1.5 or later as a new VM image (OVA or VHD; see [Installing on a Virtual Machine Image](#)). In this case, you can execute the `enable_reporting.py` script to set up embedded reporting.

- [Editing the Turbonomic cr.yaml File](#)

You have installed Turbonomic version 7.22.5 or later (up to version 8.1.5) as a new VM image.

OR

You have installed Turbonomic as a Kubernetes cluster, not using the OVA image for your Turbonomic installation.

In these cases, you manually edit the `charts_v1alpha1_x1_cr.yaml` file for your installation of Turbonomic.

Note:

If you installed Turbonomic version 7.22.4 or earlier as a VM image, contact your support representative for help enabling Embedded Reports.

Script Interface

If you have installed Turbonomic as a VM image for version 8.1.5 or later, the script to enable Embedded Reports is already installed on your installation at:

```
/opt/local/bin/enable_reporting.py
```

To execute this script:

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: `turbo`
- Username: `[your_private_password]`

2. Navigate to the script directory.

```
cd /opt/local/bin
```

3. Execute the script.

```
./enable_reporting.py
```

The script prompts you for two passwords:

- The Grafana admin password.

This password enables access to Grafana from external URLs and also from the extractor component that feeds data to Grafana.

Do not use special characters.

Important:

This is the only time that you should change the Grafana Admin password.

If you change the Grafana Admin password subsequent to completing this step, the Embedded Reporting components cannot communicate properly with the other components in the platform. If you have made a subsequent change to this password, contact your support representative.

- The Grafana database password.

This password enables communication between Grafana and the Postgres database that stores the reporting data.

After you supply the passwords, the script displays a confirmation message similar to:

```
Succesfully applied new changes to /opt/turbonomic/kubernetes/operator/deploy/crds/
charts_v1alpha1_xl_cr.yaml.
Backup written to /opt/turbonomic/kubernetes/operator/deploy/crds/
charts_v1alpha1_xl_cr.yaml.bak
```

This indicates that the script successfully updated the Turbonomic configuration. The script then applies the changed configuration to enable the Embedded Reports feature. It should display messages similar to:

```
Applying CR file /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
Warning: kubectl apply should be used on resource created by either
kubectl create --save-config or kubectl apply
xl.charts.helm.k8s.io/xl-release configured
Waiting for changes to take effect...
Restarting api pod to apply configuration changes.
pod "api-65cf47986f-jxszd" deleted
Changes have been successfully applied. Embedded reporting is now enabled.
```

4. Verify your installation.

Execute the command:

```
./enable_reporting.py --validate
```

If Embedded Reports are successfully enabled, the script output should be:

```
No obvious embedded reporting installation errors detected.
```

Editing the Turbonomic cr.yaml File

These instructions describe how to locate and edit the `charts_v1alpha1_xl_cr.yaml` for the VM image installation. If you installed on a Kubernetes node cluster, then the file can be in a different location.

To enable Embedded Reports, you will:

- Enable the processes that implement the embedded reporting.
- Update the API pod to enable new search and data ingestion capabilities.
- Double-check the installation.
- Enable PDF reports and email subscriptions (optional).

You must enable the Grafana Exporter, TimescaleDB, and data extraction processes. To do this, edit the `charts_v1alpha1_xl_cr.yaml` file.

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Username: [your_private_password]

2. Open the following file in a text editor:

```
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

3. Specify the IP address of the Turbonomic instance for external access to the TimescaleDB database.

In the `global:` section of the file, add the following line, where **<Platform_IP>** is the IP address of your instance:

```
global:
  externalTimescaleDBIP: <Platform_IP>
```

4. Enable the Grafana process.

Find the `grafana:` section in the `crds/charts_v1alpha1_xl_cr.yaml` file, and uncomment the line, `enabled: true`.

5. Enable Postgres as the database type.

Enabling Postgres sets persistent storage of historical data for Embedded Reports. In the `grafana:` section, find the subsection for `grafana.ini: database:` and uncomment the line, `type: postgres`.

The changes you have made so far should be similar to:

```
global:
  externalTimescaleDBIP: <Platform_IP>
  ...

grafana:
  enabled: true
  adminPassword: admin
  grafana.ini:
    database:
      type: postgres
    ...
```

6. Change the admin and database passwords.

It is good practice to change any passwords, and not keep their default values.

Important:

Use only alpha-numeric characters for these passwords.

These passwords enable communication between the various Embedded Reports components. Some of the components only accept alpha-numeric characters. If you use special characters, then the components will not be able to communicate. Further, the steps to correct these passwords require assistance from your Support engineer.

To set the passwords:

- Set the Grafana admin password.

This password enables access to Grafana from external URLs and also from the extractor component that feeds data to Grafana. In the `grafana:` section, change the value of `adminPassword`.

Do not use special characters.

Assume your password is `MyNewGrafanaPassword`. Then you would set `adminPassword:`

MyNewGrafanaPassword

Important:

This is the only time that you should change the Grafana Admin password.

If you change the Grafana Admin password subsequent to completing this step, the Embedded Reporting components cannot communicate properly with the other components in the platform. If you have made a subsequent change to this password, contact your support representative.

- Set the Grafana database password.

This password enables communication between Grafana and the Postgres database that stores the reporting data. In the `grafana:` section, find the subsection for `grafana.ini: database:` `password:` and change the password value.

7. Enable the three Embedded Reports processes.

Just after the `properties:` section that you added, and at the same level to it, add the following entries to enable the reporting processes:

```
reporting:
  enabled: true
timescaledb:
  enabled: true
extractor:
  enabled: true
```

It is important that you align these entries with the indentation for the `grafana:` section and the `properties:` section. The changes you have made should now be similar to:

```
global:
  externalTimescaleDBIP: <Platform_IP>
  ...

grafana:
  enabled: true
  adminPassword: MyNewGrafanaPassword
  grafana.ini:
    database:
      type: postgres
      password: MyNewDatabasePassword

properties:
  extractor:
    grafanaAdminPassword: MyNewGrafanaPassword

reporting:
  enabled: true
timescaledb:
  enabled: true
extractor:
  enabled: true
```

8. When you are done editing the `charts_v1alpha1_xl_cr.yaml` file, save and apply your changes.

- Save your changes and quit the text editor.
- Apply the changes.

Execute the command:

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

- Delete the api and extractor pods.

Deleting these pods triggers them to restart, which loads the changes you made.

To get the full pod names, execute the command, `kubectl get pods -n turbonomic`. Then find the two entries for the pods that begin with `api` and `extractor`. For example, assume the entries are:

```
...
api-7887c66f4b-shndq          1/1      Running   0
...
extractor-5b86976bc8-vxwz4    1/1      Running   0
...
```

Then you would execute the commands:

- `kubectl delete pod -n turbonomic api-7887c66f4b-shndq`
- `kubectl delete pod -n turbonomic extractor-5b86976bc8-vxwz4`

9. Verify your installation.

To double-check the installation:

- Verify that the Embedded Reports pods are running.

To verify that the pods are running, execute `kubectl get pods -n turbonomic`. The output should include entries similar to:

NAME	READY	STATUS	RESTARTS
extractor-7759dbcb47-vs6hr	1/1	Running	0
grafana-84ccb4bfb-17sp7	1/1	Running	0

- Verify that Postgres is running.

The Postgres database should be running as a daemon on the Turbonomic server machine. To check the status, execute the command:

```
sudo systemctl status postgresql-12.service.
```

You should see output similar to:

```
postgresql-12.service - PostgreSQL 12 database server
Loaded: loaded (/usr/lib/systemd/system/postgresql-12.service; enabled; vendor preset: disabled)
Active: active (running) since Wed 2020-07-29 06:39:43 UTC; 14h ago
    Docs: https://www.postgresql.org/docs/12/static/
Process: 1536 ExecStartPre=/usr/pgsql-12/bin/postgresql-12-check-db-dir ${PGDATA} (code=exited, status=0/SUCCESS)
Main PID: 1562 (postmaster)
   Tasks: 15
  Memory: 145.5M
    CGroup: /system.slice/postgresql-12.service
            └─ 419 postgres: TimescaleDB Background Worker Scheduler
              1562 /usr/pgsql-12/bin/postmaster -D /var/lib/pgsql/12/data/
              1928 postgres: logger
              1986 postgres: checkpointer
              1988 postgres: background writer
              1989 postgres: walwriter
              1990 postgres: autovacuum launcher
              1991 postgres: stats collector
              1992 postgres: TimescaleDB Background Worker Launcher
              1994 postgres: logical replication launcher
              4054 postgres: grafana_backend grafana 10.233.90.172(33038) idle
              4884 postgres: grafana_backend grafana 10.233.90.172(35814) idle
              4912 postgres: grafana_reader extractor 10.233.90.172(33898) idle
             11365 postgres: grafana_reader extractor 10.233.90.172(40728) idle
             32367 postgres: TimescaleDB Background Worker Scheduler
```

(Optional) Report Editing, PDFs, and Email Subscriptions

After you have completed the steps to enable Embedded Reports, you can click **Reports** in the Turbonomic Navigation Bar to open Grafana dashboards in a new browser tab. From there you can view the list of existing dashboards.

To create and edit reports from this view, and to send these reports to subscribers, you must:

- Configure a single Report Editor user account.

This user has privileges to create and edit reports, create PDFs, and set up email subscriptions.

- Install a Grafana license in Turbonomic.

This license is free of charge.

- Configure the Turbonomic email proxy to enable email messages sent from Turbonomic.

This enables emailing the reports from Turbonomic

Note:

Turbonomic Embedded Reports use Grafana dashboards to display reports. For instructions to generate PDFs from the reports, and have Grafana email them to subscribers, see the Grafana Reporting documentation:

<https://grafana.com/docs/grafana/latest/enterprise/reporting/>

Configuring a User Account with Report Editor Privileges

The ability to edit reports requires a licensed user. The user account you configure here will have access to that license, which gives the user privileges to edit reports and set up subscriptions.

To create the user account:

1. In Turbonomic, display the User Management page.

Navigate to **Settings / User Management**.

2. Choose the user account that you want to configure as a Report Editor.

You can either edit an existing account or create a new one.

3. Choose a role for the user.

The user can have any role so long as it is not a *Shared* role or a *Scoped* role.

4. Set the Report Editor privileges.

Under **Options**, choose **DESIGNATE AS REPORT EDITOR**.

5. Set any other properties for the user account that you want, and save the user account.

For complete information about creating user accounts, see "Managing User Accounts" in the *Turbonomic User Guide*.

Installing the Grafana License

For the Report Editor user account to use the licensed privileges, you must install a Grafana license. To install your Grafana license:

1. Request the free license.

Contact your support representative to request the license file. This request must include the Turbonomic URL to your reporting page. For example, assume you log into the Turbonomic user interface through the domain **MyCompany.com**. Then you would provide the URL:

```
https://MyCompany.com/reports/
```

This URL is incorporated in the license file to ensure that the license applies to the domain you provide.

2. Save the file to your local machine.

The file should have a `.jwt` filename extension.

3. Install the `.jwt` file as a license in Turbonomic.

Install the license file the same as you install any license in Turbonomic"

- a. Navigate to the License page.

Navigate to **Settings / License**.

- b. Apply the license to your Turbonomic instance.

First click **Import License**. Then drag the license file into the **Enter License** fly-out. Or you can browse to the license file on your local machine and then open it.

After you install the license, navigate to the Reports view (click **Reports** in the Turbonomic Navigation Bar. When you navigate to a dashboard, and click **Share Dashboard**, you can now choose to create a PDF. To email that PDF of the dashboard, you must configure the SMTP relay on Turbonomic.

Configuring the SMTP Relay

The SMTP relay enables Turbonomic to send emails to your report subscribers. To configure the SMTP relay on Turbonomic:

1. Navigate to the Email Settings page.

Navigate to **Settings / Email and Trap Notifications**.

2. Configure the SMTP settings.

The SMTP Settings fields identify the mail relay server you use on your network to enable email communication from Turbonomic. The relay you set up here enables emails from to send reports to subscribers.

If the server requires authentication, provide the username and password here. You can also choose the following encryption options for notifications:

- None
- Ssl
- Tls

3. Configure the return address for emails sent by Turbonomic.

Provide a FROM address in the General Email Settings section.

After you have created a Report Editor user, installed the Grafana license, and configured the SMTP relay, the user can create PDFs of the dashboards, and send them to subscribers.

Embedded Reports Storage Requirement Estimates

The Embedded Reports feature uses a TimescaleDB server to manage the chart data. This is a PostgreSQL server running with the TimescaleDB extension. You must configure the datastore for your Turbonomic instance so it has enough space to support the TimescaleDB requirements.

When you initially enable Embedded Reports, you should estimate the storage you will need, and configure the platform storage accordingly. If you have already enabled Embedded Reports, you should check your current storage configuration and decide whether it meets your needs now and into the future.

The storage that your TimescaleDB requires depends on:

- Data retention period

How long to store the TimescaleDB data.

- The size of your environment

The count of entities Turbonomic manages in your environment. This count changes over time. You should think of it as the average number of entities in your environment over the given data retention period.

Also note that increased entity count increases the data requirement, as does other activity. Storage requirements can increase over time for reasons such as:

- You add entities such as workloads, application components, storage, or hosts to your environment.
- You configure new targets.

Storage Estimates Lookup Tables

We have investigated the TimescaleDB storage requirements for different topologies and retention periods. The following table lists the estimates that we have calculated. Please be aware that your environment could have different requirements.

	Number of Entities						
Retention Period	10k	25k	50k	100k	250k	500k	1000k
6 months	36GB	91GB	182GB	364GB	910GB	1.8TB	3.6TB
1 year	72GB	181GB	361GB	723GB	1.8TB	3.5TB	7TB

	Number of Entities						
Retention Period	10k	25k	50k	100k	250k	500k	1000k
2 years	144GB	361GB	721GB	1.4TB	3.5TB	7.2TB	14TB

Note that the default installation grants a disk quota of 200GB to the TimescaleDB. For the default installation, we estimate that the database can support the following entity counts:

Retention Period	Entity Count
6 months	55k
1 year	27k
2 years	14k

Setting the Data Retention Period

By default, Turbonomic sets the retention period for Embedded Reports to be 365 days. You can see the currently set retention period, and change it in the Turbonomic user interface.

To execute these actions, navigate to the Maintenance Options page:

1. Navigate to the Settings Page.



Click to navigate to the Settings Page.

2. Choose Maintenance Options.



Maintenance Options

3. Set the data retention period for Embedded Reports.

In the **Data Retention** group of controls, find the field for **Saved Reporting Data**. This displays the current data retention period for Embedded Reports, in days. The default is 365 days.

To change the retention period, enter a different number of days, and then click **Apply Settings**.

Increasing Storage Capacity for TimescaleDB

If you estimate the storage requirements for Embedded Reports *after* you have installed Turbonomic, you might learn that you need to increase the storage capacity that is available to the TimescaleDB.

The platform uses Logical Volume Management (LVM) to manage the VM disks. To increase database storage, you should add a new disk to the VM, and then use it to extend the LVM logical volume, `/dev/turbo/var_lib_mysql`. This logical volume serves both the historical database and the Embedded Reports database. When you have done that, you will increase the quota for the TimescaleDB.

For more information, see [Increasing Available Disk Space](#)

Estimating Entity Count

To get a sense of entity count in your environment, search the Turbonomic log file for an INFO message that lists the number of entities for each discovery cycle. You can search for the string INFO [Stages\$BroadcastStage]. The INFO string should be similar to:

```
topology-processor-6f6486df64-zf 2021-09-27 20:51:33,724 INFO  
[Stages$BroadcastStage] : Successfully sent 1505 entities within topology...
```

This example shows that you have 1505 entities in the topology. You should consider how your inventory changes over time. For example, you can check the entity count over time to see whether it increases regularly.

(Optional) Enabling the Data Exporter

To support Data Export, Turbonomic provides an extractor component that can stream data to a standard format. You can load that data into search and analytics services such as Elasticsearch.

To enable the Data Exporter, you must:

- Enable the extractor component.

The extractor is a component that runs as part your Turbonomic installation. The extractor is not enabled by default.

- Deploy a connector that delivers the extractor's stream to your data service.

The extractor publishes Turbonomic data as Kafka topics. The connector enables your data service to consume the data topic. This document includes a deployment file for a sample Elasticsearch connector.

Enabling the Extractor Component

The first step to enabling the Data Exporter is to enable the extractor component. To enable the extractor:

1. Open an SSH terminal session to your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username: turbo
- Username: [your_private_password]

2. Edit the cr.yaml file to enable the extractor component.

In the same SSH session, open the cr.yaml file for editing. For example:

```
vi /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

3. Edit the entry for the extractor component.

Note:

If you have enabled Embedded Reporting, then the extractor component will already be enabled (set to `true`).

You should understand that it is possible to enable the Data Exporter without enabling Embedded Reports, just as it is possible to enable Embedded Reports without enabling the Data Exporter.

Search for the extractor entry in the cr.yaml file. It should appear as:

```
extractor:  
  enabled: false
```

Change the entry to `true`.

4. Edit the entry for the extractor properties.

Search for the extractor entry in the cr.yaml file. It should appear as:

```
properties:
  extractor:
    enableDataExtraction: false
```

Change the entry to true.

5. Save and apply your changes to the platform.

After you save your changes, use `kubectl` to apply the changes:

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

6. Verify that the extractor component is running.

Give the platform enough time to restart the components. Then execute the command:

```
kubectl get pods -n turbonomic
```

You should see output similar to the following:

NAME	READY	STATUS	RESTARTS
...			
extractor-5f41dd61c4-4d61q	1/1	Running	0
...			

Look for an entry for the extractor component. If the entry is present, then the extractor component is installed and running.

Deploying a Connector

The extractor publishes Turbonomic data as Kafka topics. To load this data into a search and analysis service, you must deploy a connector to that service. For example, if you want to load the data into Elasticsearch, then you must deploy an Elasticsearch connector.

You deploy the connector in the same Kubernetes node that runs the Turbonomic platform. To do this, create a Kubernetes *Deployment* that declares the pods you need for the connector. Below, you can see a sample deployment of a connector to Elasticsearch.

To deploy the connector, you create a deployment yaml file on the same host that is running the extractor component, and execute the command:

```
kubectl create -f <MyConnectorDeployment.yaml>
```

Where **<MyConnectorDeployment.yaml>** is the name of the deployment file.

Assume the name of the deployed pod is `es-kafka-connect`. To verify that the connector is running, execute `kubectl get pods -n turbonomic`. You should see output similar to:

NAME	READY	STATUS	RESTARTS
...			
es-kafka-connect-5f41dd61c4-4d61q	1/1	Running	0
...			

After you deploy the connector, wait for a cycle of Turbonomic analysis (approximately ten minutes). Then you should be able to see the entities and actions from your Turbonomic environment, loaded as JSON in your data service.

Connector Deployment Sample

Assume that you want to deploy a connector to Elasticsearch so that service can process the exported data. For example, you could use Kibana with Elasticsearch to display data dashboards. Let's say you have:

- Deployed Elasticsearch to a VM on the network where you are running Turbonomic. The Elasticsearch host is visible from the Turbonomic Kubernetes node. You will specify this host address in the connector deployment.
- Set up an Elasticsearch index to load the Turbonomic data. You will specify this index in the connector deployment.

The following listing is a deployment that uses a Logstash image to collect the extractor data and pipe it to the Elasticsearch host. The deployment also sets up storage volumes, configures the input from the extractor, and configures output to the Elasticsearch instance.

As you go over the listing, pay attention to the following:

- The location of the Elasticsearch host and the login credentials:

```
...
    env:
      - name: ES_HOSTS
        value: "<UrlToMyElasticsearchHost>"
      - name: ES_USER
        value: "<MyElasticsearchUser>"
      - name: ES_PASSWORD
        valueFrom:
          secretKeyRef:
            name: <MyES_KeyName>
            key: <MyES_Key>
...

```

Logstash will use the following environment variables:

- ES_HOSTS: to identify where to pipe the exported data.
- ES_USER: to identify the user account on Elasticsearch.
- ES_PASSWORD: for the account login. This connector example assumes that you have stored the Elasticsearch password as a Kubernetes Secret.

Logstash uses the ES_HOSTS environment variable to identify where to pipe the exported data.

- The name of the Kafka topic:

```
...
  logstash.conf: |
    input {
      kafka {
        topics => ["turbonomic.exporter"]
      }
    }
...

```

The Logstash input configuration expects a single topic named `turbonomic.exporter`.

- The Logstash output configuration is to the Elasticsearch server that is identified by the ES_HOSTS environment variable. You specify your own Elasticsearch index in place of **<MyElasticsearchIndex>**

```
...
    output {
      elasticsearch {
        index => "<MyElasticsearchIndex>"
        hosts => [ "${ES_HOSTS}" ]
      }
    }
...

```

Sample Listing: Elasticsearch Connector

This listing is a sample of a deployment file that can work to create an Elasticsearch connector for the Data Exporter. Note that you will need to change some settings, such as username and password. You also might need to specify ports and other settings to make the connector comply with your specific environment.

```
apiVersion: apps/v1
kind: Deployment

```

```

metadata:
  name: elasticsearch-kafka-connect
  labels:
    app.kubernetes.io/name: elasticsearch-kafka-connect
spec:
  replicas: 1
  selector:
    matchLabels:
      app.kubernetes.io/name: elasticsearch-kafka-connect
  template:
    metadata:
      labels:
        app.kubernetes.io/name: elasticsearch-kafka-connect
    spec:
      containers:
        - name: logstash
          image: docker.elastic.co/logstash/logstash:7.10.1
          ports:
            - containerPort: 25826
          env:
            - name: ES_HOSTS
              value: "<UrlToMyElasticsearchHost>"
            - name: ES_USER
              value: "<MyElasticsearchUser>"
            - name: ES_PASSWORD
              valueFrom:
                secretKeyRef:
                  name: <MyES_KeyName>
                  key: <MyES_Key>
            resources:
              limits:
                memory: 4Gi
              volumeMounts:
                - name: config-volume
                  mountPath: /usr/share/logstash/config
                - name: logstash-pipeline-volume
                  mountPath: /usr/share/logstash/pipeline
            volumes:
              - name: config-volume
                configMap:
                  name: logstash-configmap
                  items:
                    - key: logstash.yml
                      path: logstash.yml
              - name: logstash-pipeline-volume
                configMap:
                  name: logstash-configmap
                  items:
                    - key: logstash.conf
                      path: logstash.conf
            ---
apiVersion: v1
kind: ConfigMap
metadata:
  name: logstash-configmap
data:
  logstash.yml: |
    http.host: "0.0.0.0"
    path.config: /usr/share/logstash/pipeline
  logstash.conf: |
    input {
      kafka {
        topics => ["turbonomic.exporter"]
        bootstrap_servers => "kafka:9092"
        client_id => "logstash"
        group_id => "logstash"
        codec => "json"
        type => "json"
        session_timeout_ms => "60000" # Rebalancing if consumer is found dead
        request_timeout_ms => "70000" # Resend request after 70 seconds
      }
    }
    filter {
    }
    output {
      elasticsearch {
        index => "<MyElasticsearchIndex>"
        hosts => [ "${ES_HOSTS}" ]
        user => "${ES_USER}"
        password => "${ES_PASSWORD}"
      }
    }

```



```

---
apiVersion: v1
kind: Service
metadata:
  labels:
    app: elasticsearch-kafka-connect
    name: elasticsearch-kafka-connect
spec:
  ports:
    - name: "25826"
      port: 25826
      targetPort: 25826
  selector:
    app: elasticsearch-kafka-connect

```

(Optional) Changing the IP Address of the Platform Node

For standard installations of Turbonomic (installed as a VM image), you might need to change the platform's IP address. For example, if you have to move the VM then you might need to assign it a different address. If you must change the IP address of the platform, you can use the supplied scripts.

Note:

You should change the IP address of your Turbonomic installation as seldom as possible. This is a sensitive action that can impact unforeseen dependencies.

You can safely use the following steps to change your IP address if your installation satisfies one of the following conditions:

- You initially installed the platform OVA as version 8.0.6 or later.
- You have updated your Turbonomic to version 8.0.7 or later.

If your installation does not meet either one of these conditions, *do not use the following instructions to change the IP address*. If you must change your IP address and you cannot update to version 8.0.7 or later, contact your support representative.

To change the IP address of the Turbonomic VM:

1. Get your information ready.

Identify both the current IP address for your platform, and the new IP address you will use.

You must also know the credentials to open a shell session on the VM and run commands.

2. Create a full snapshot of the VM.

It is important to make a full snapshot of your installation before you try to modify its IP address.

3. Change the VM's IP address.

The Turbonomic VM includes the `ipsetup` script to perform this task.

- a. Open an SSH terminal session to your Turbonomic VM.

Use the following credentials:

- Username: `turbo`
- Password: Give the password that you assigned the `turbo` account when you first installed the platform.

- b. Once the session is open, execute the `ipsetup` script:

```
sudo /opt/local/bin/ipsetup
```

When the script runs it requests the following inputs.

Note:

You must provide values for these required fields. Otherwise the installation can fail or your VM can be unreachable:

- **Required:** Do you want to use DHCP or set a static IP...
Choose static
- **Required:** Please enter the IP Address for this machine
- **Required:** Please enter the network mask for this machine
- **Required:** Please enter the Gateway address for this machine
- **Required:** Enter DNS Server(s) IP Address for this machine

You should make a note of the IP address that you provide.

- c. Propagate your IP change through to the Kubernetes cluster on the VM.

```
sudo /opt/local/bin/kubeNodeIPChange.sh
```

- d. Verify that the change is successful.

Log into the Turbonomic user interface for the newly located installation, and ensure that it displays correctly. You should review the Supply Chain, your groups, and your policies. You should also ensure that charts show data correctly.

When you are sure that the change is successful, you can remove the snapshot you made of the VM in its old location.

(Optional) Enabling and Disabling Probe Components

In Turbonomic, a probe is a platform component that connects to a target. It discovers the target's entities and loads them into the Turbonomic supply chain, and it can execute actions on the devices in the target environment. Turbonomic ships with a large number of probe components that you can use to connect Turbonomic with your environment.

When you first install Turbonomic, it enables a certain set of probes by default, and leaves other disabled. Each probe consumes resources in your Turbonomic installation. If there are any probes that you do not need, then you should consider disabling them. On the other hand, if there are disabled probes that you do need, you must enable them to put them into service.

Note:

Before you perform your Turbonomic update, you should check the What's New section of the User Guide (see [What's New](#)).

As Turbonomic evolves, the set of delivered probes can change. Also, from one version to the next, the set of probes that are enabled by default can change. However, when you update to a new version, the update does not change your probe configuration. An update to a newer version does not automatically enable any new probes in your deployment. If you want to take advantage of new probes in an update, then you must enable them manually.

Viewing the Current List of Available Probes

As you update your version of Turbonomic, more probes can come available with the update. However, the update does *not* modify your current configuration of enabled or disabled probes. This means that any new probes that come with an update will not be available to you by default.

To enable any new probes, you must first know the internal name for the probe. To get a list of probes that are *available* to your current version, you can view the contents of the `values.yaml` file.

1. Open an SSH terminal session on your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username:

```
turbo
```

- Password:

```
[your_private_password]
```

2. Display the list of available probes.

```
cat /opt/turbonomic/kubernetes/operator/helm-charts/x1/values.yaml
```

The results should be similar to:

```
customdata:
  enabled: false
dynatrace:
  enabled: false
gcp:
  enabled: false
hpe3par:
  enabled: false
...
```

This list gives the internal names of the probes. If you want to add a new probe to your list of configured probes, you must use the internal name, and set `enabled: true`.

Viewing the Current List of Configured Probes

Your current installation of Turbonomic has a certain set of available probes. Some of these will be enabled, and it is likely that some probes are disabled. To View the current configuration of probes that are currently available, open the `cr.yaml` file for your Turbonomic installation and review the probe entries:

1. In the same SSH session, open the `cr.yaml` file for editing. For example:

```
vi /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

2. Search for the list of probes

This will include all the probes that are configured for your current installation. The list will be similar to:

```
actionscript:
  enabled: true
appdynamics:
  enabled: true
appinsights:
  enabled: true
aws:
  enabled: true
azure:
  enabled: true
dynatrace:
  enabled: true
hpe3par:
  enabled: true
horizon:
  enabled: false
hyperflex:
  enabled: false
...
```

This list identifies all the probes that are currently configured for your installation, and shows whether they are enabled (`true`) or disabled (`false`).

Note:

This list of probes is not identical to the list of probe *Pods* that are running in your installation. Some probes use multiple pods. Probe pod names use the following convention, where **{ProbeName}** is the probe internal name (in the lists above), and **{NameExtension}** is an optional extension to that name in case there are multiple pods for this probe:

```
mediation-{ProbeName}{NameExtension}
```

For example, if you execute `kubectl get pods -n turbonomic`, the results can show the following for the vcenter probe:

NAME	READY	STATUS	RESTARTS
mediation-vcenter-5bc4f5fbd4-nzm4j	1/1	Running	0
mediation-vcenterbrowsing-5c5987f66c-bfjq4	1/1	Running	0

Enabling/Disabling Probes

To enable or disable probes in Turbonomic, you will edit the `cr.yaml` file to add new probes and to change the values of the `enabled:` properties. Then you will apply those changes to reload the platform components.

1. In the same SSH session, open the `cr.yaml` file for editing. For example:

```
vi /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

2. Edit the probe entries.

To enable or disable currently configured probes, find the probes you want to edit and change the settings to enable or disable them.

To add new probes to the list, copy the probe entry you want from the output when you used `cat` to view the available probes. Then paste that entry into the `cr.yaml` file and set `enabled: true`.

3. Save and apply your changes to the platform.

After you save your changes, use `kubectl` to apply the changes:

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

4. Verify that the probes have installed correctly and all the Turbonomic pods have started.

Execute `kubectl get pods -n turbonomic` and review the list for the mediation pods that implement your probes. Note that all pods should display `READY` and `STATUS` states similar to:

NAME	READY	STATUS	RESTARTS
[...]	1/1	Running	0

5. View the new probe configuration in the user interface.

Refresh your browser and navigate to the Target Management page. You should now see the target categories and types to match your configuration changes.

License Installation and First-time Login

Before you begin, make sure you have your full or trial license key file that was sent to you in a separate email. Save the license file on your local machine so you can upload it to your Turbonomic installation.

To use Turbonomic for the first time, perform the following steps:

1. Type the IP address of your installed Turbonomic instance in a Web browser to connect to it.
2. Log in to Turbonomic.
 - Use the default credential for **USERNAME**: administrator.
 - Type a password for **PASSWORD**.
 - Type the password again to verify it for **REPEAT PASSWORD**.
 - Click **CONFIGURE**.
3. Continue setting up your Turbonomic installation.

Click **LET'S GO**.

4. Open the **Enter License** fly-out.

Click **IMPORT LICENSE**.

5. Upload your license key file.

a. In the Enter License fly-out, you can upload the license in one of the following ways:

- Drag the license key file into the Enter License fly-out.
- Browse to the license key file.

Be sure to upload only .xml or .lic files.

b. Click **SAVE**.

Depending on which license you have installed, the license enables either a trial or a full unlimited license for Turbonomic.

Single Sign-On Authentication

If your company policy supports Single Sign-On (SSO) authentication, you can configure Turbonomic to support SSO authentication via either Security Assertion Markup Language (SAML) 2.0 or OpenID Connect 1.0.

At a high-level, to do this you will:

- Create external groups or at least one external user for SSO. See "Managing User Accounts" in the *Turbonomic User Guide*.
- Configure Turbonomic to use SSO authentication.

You will configure one of:

- SSO via a SAML Identity Provider (IdP). See [Setting Up SAML Authentication](#).
- SSO via an OpenID Identity Provider. See [Setting Up OpenID Authentication](#).

This section describes how to configure Turbonomic to use either SAML or OpenID to support SSO.

When SSO is enabled, users will provide their SSO credentials to log in to the Turbonomic instance. Once SSO is enabled, users cannot give local or Active Directory (AD) credentials for to login. The Identity Provider (IdP) will perform the authentication.

Prerequisites

Before you begin, make sure the IdP is set up for SSO. You can use a proprietary or public IdP. For examples of settings for a public Okta IdP, see [What Are the Typical Settings for an IdP?](#).

Setting Up SAML Authentication

Security Assertion Markup Language (SAML) is an XML-based open standard for exchanging authentication and authorization data between parties. To configure Turbonomic to authenticate via SAML:

1. (Required) Create external groups or at least one external user for SSO.

Important:

When SSO is enabled, Turbonomic only permits logins via the SSO IdP. Whenever you navigate to your Turbonomic installation, it redirects you to the SSO Identity Provider (IdP) for authentication before displaying the Turbonomic user interface.

Before you enable SSO for your Turbonomic installation, *you must configure at least one SSO user with Turbonomic administrator privileges*. If you do not, then once you enable SSO you will not be able to configure any SSO users in Turbonomic. To authorize an SSO user as an administrator, use **EXTERNAL AUTHENTICATION** to do one of the following:

- Configure a single SSO user with administrator authorization.

Add an external user. The username must match an account that is managed by the IdP.

- Configure an SSO user group with administrator authorization.

Add an external group. The group name must match a user group on the IdP, and that group must have at least one member.

For information about creating external groups or external users for SSO, see "Managing User Accounts" in the *Turbonomic User Guide*.

2. (Required) Ensure that chrony is configured and the system time on your Turbonomic instance is correct.

For instructions, see [Synchronizing Time](#).

3. Obtain the metadata from your IdP.

You will use this metadata to configure SSO in the Turbonomic CR file located at:

```
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

To get the metadata:

- a. Contact your security administrator to obtain the metadata from IdP.
- b. Save the metadata file in a directory on your local machine. For example, save the file to:

```
/tmp/MySamlMetadata.txt
```

- c. Compare your metadata to the sample provided in [Example of IdP Metadata](#).

Cat out the file you just saved. It should be similar to the provided sample.

4. Obtain a certificate from IdP.

Contact your security administrator to obtain a certificate from IdP.

5. Update the CR file with your SAML configuration.

You now have the data that you need to configure SSO via SAML. You will edit the `cr.yaml` file that configures your Turbonomic node, and then deploy or restart the node.

- Display the contents of your downloaded SAML metadata.

For example, assuming you saved the file to this location on your local machine, execute the command:

```
cat /tmp/MySamlMetadata.txt
```

- Open the CR file for editing.

In a shell, `cd` to the `deploy/crds` directory in the Turbonomic VM:

```
cd /opt/turbonomic/kubernetes/operator/deploy/crds
```

Then open the CR file for editing. For example, to open the file in VI:

```
vi charts_v1alpha1_x1_cr.yaml
```

As you edit this file, you will refer to the metadata that you obtained from your IdP.

- In the CR file, navigate to the entry for the API component.

In the CR file search for or scroll to the entry:

```
apiVersion: charts.helm.k8s.io/v1alpha1
```

You will make changes to this component spec, under `spec:properties:api:`

- Turn on the SAML feature.

For the first API property, set the following:

```
samlEnabled: true
```

- Set the SSO endpoint

In the SAML metadata, find the entry for `md:SingleSignOnService`. Within that element, find the `Location` attribute. The value of `Location` is the SSO endpoint. Using the sample metadata we have provided, you would make the following setting in your CR file:

```
samlWebSsoEndpoint: https://dev-771202.oktapreview.com/app/ibmdev771202_turbo2_1/exkexl6xc9MhzqiC30h7/sso/saml
```

- Set the SAML entity ID

In the SAML metadata, find the entry for `md:EntityDescriptor`. Within that element, find the `entityID` attribute. Using the sample metadata we have provided, you would make the following setting in your CR file:

```
samlEntityId: http://www.okta.com/exkexl6xc9MhzqiC30h7
```

- Set the SAML registration

Set the following property:

```
samlRegistrationId: simplesamlphp
```

- Set the SAML SP entity ID

Set the following property:

```
samlSpEntityId: turbo
```

- Enter the SAML certificate

In the metadata that you got from your IdP, find the entry for `<ds:X509Certificate>`. Copy the contents of this tag – copy the characters that are between `<ds:X509Certificate>` and `</ds:X509Certificate>`.

Create an entry for the certificate in the API properties section of the CR file. On a new line, enter:

```
samlIdpCertificate: |
```

Then open a new line after the entry you just created, and paste the certificate content that you copied from your metadata file.

The finished API section of the CR file should be similar to the following:

```
apiVersion: charts.helm.k8s.io/v1alpha1
kind: X1
metadata:
  name: x1-release
spec:
  properties:
    api:
      samlEnabled: true
      samlWebSsoEndpoint: https://dev-771202.oktapreview.com/app/ibmdev771202_turbo2_1/exkexl6xc9MhzqiC30h7/sso/saml
      samlEntityId: http://www.okta.com/exkfdsn6oy5xywqC00h7
      samlRegistrationId: simplesamlphp
      samlSpEntityId: turbo
      samlIdpCertificate: |
        -----BEGIN CERTIFICATE-----
        MIIDpDCCAoygAwIBAgIGAWMnhv7cMA0GCSqGSIb3DQEBCwUAMIGSMQswCQYDVQQGEwJVUzETMBEG
        A1UECAwKQ2FsaWZvcn5pYTEwMBQGA1UEBwwNU2FuIEZyYW5jaXNjbzENMAsGA1UECgwET2t0YTEU
        MBIGA1UECwwLU1NPUHJvdmlkZXIxExZARBgNVBAMTCmRldi03NzEyMDIxHDAaBgkqhkiG9w0BCQEW
        DWluZm9Ab2t0YS5jb20wHhcNMjgwNTA0MTI4WmcNMjgwNTA0MTk0MjI4WjCBKjEELMAkGA1UE
        BHMCMVVMxExZARBgNVBAGMCKNhbg1mb3JuaWExFjAUBGNVBACMDVNhbiBGcmFuY2lyZ28xDTALBgNV
        BAoMBE9rdGExFDASBgNVBASMC1NTT1Byb3ZpZGVyMRMwEQYDVQQDDApkZXl0NzcxMjAyMRwwGgYJ
        KoZIIhvcNAQkBFg1pbmZvQG9rdGEuY29tMIIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEA
        ugXQGqHAXpjVQZws09n818bFCoEevH3AZbz7568XuQm6MK6h7/09wB4C5oUYddemt5t2Kc8GRhf3
        BDXX5MVZ8G9AUpG1MSqe1CLV2J96rMnwMIJskRXr01LYxv/J4kjkntpOC389wmcY2fE4RbPoJne
        P4u2b32c2/V7xsJ7UEjPPSD4i812QG6qsUkx3AyNsjo89PekMfm+Iu/dFKXkdjwXZXPxaL0HrNW
```

```
PTpzek8NS5M5rvF8yaD+eE1zS0I/HicHbPOVvLa10JZYn/f4bp0XJkxZJz6jF5DvBkwIs8/Lz5GK
nn4XW9Cqjk3equSCJPo5o1Msj8v1LrJYVarqhwIDAQABMA0GCSqGSIb3DQEBCwUAA4IBAQC26kYe
LgqjIkF5rvxB2QzTgcd0LVzX0uiVVTZr8Sh5714jJqbDoIgvaQQrxRSQzD/X+hcmhuwdp9s8zPHS
JagtUJXiypwNtrzbF6M71trWB9sdNrqc99d1g0VRr0Kt5pLTaLe5kkq7dRaQo0IIVJhX9wgynaAK
HF/SL3mHUytjXggs88AAQa8JH9hEpwG2srN8EsizX6xwQ/p92hM2oLvK5CSMwTx4VBuGod70E0wp
6Ta1uRLQh6jCC0CWruZbbz2T3/s0X+sibC4rLiLwfyTkcUopF/bTSdWwknoRskK4dBekFcvN9N+C
p/qaHYcQd6i2vyor888DLHDPXhSKWhpG
-----END CERTIFICATE-----
```

6. Save your changes to the CR file.

7. Apply the modified cr.yaml file.

Execute the command:

```
kubectl apply -f /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

8. Restart the API component to load the new spec.

a. Open an SSH terminal session to your Turbonomic instance.

b. Restart the API component.

```
kubectl delete pod api- <API_POD_ID> (NOTE: To auto-fill the pod ID, type api- and then press TAB.)
```

9. Verify that the configuration is successful.

a. Navigate to the Turbonomic User Interface.

You will be automatically redirected to your IdP for authentication.

b. Log in with the username that is a member of the external group or external user that you previously configured.

c. Verify that the system time on your Turbonomic instance is correct.

If the time is not synchronized, this might cause an HTTP Status 401 -authentication failed exception in the browser.

d. If the configuration is not successful, look for an HTTP Status 500 exception in the product log. If this exception exists, review your CR file for invalid entries.

Example of IdP Metadata

This section provides an example of IdP metadata which may be useful when you are examining the optional attributes in your metadata.

If your metadata includes optional attribute tags that are not listed in the example, remove those optional attribute tags since they are not supported.

```
<?xml version="1.0" encoding="UTF-8"?>
<md:EntityDescriptor xmlns:md="urn:oasis:names:tc:SAML:2.0:metadata"
entityID="http://www.okta.com/exkexl6xc9MhzqiC30h7">
<md:IDPSSODescriptor WantAuthnRequestsSigned="false"
protocolSupportEnumeration="urn:oasis:names:tc:SAML:2.0:protocol">
<md:KeyDescriptor use="signing">
<ds:KeyInfo xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
<ds:X509Data>
<ds:X509Certificate>
MIIDpDCCAoygAwIBAgIGAWMnhv7cMA0GCSqGSIb3DQEBCwUAMIGSMQswCQYDVQQGEwJVUzETMBEG
A1UECAwKQ2FsaWZvcM5pYTEwMBQGA1UEBwwNU2FuIEZyYW5jaXNjbzENMAsGA1UECgwET2t0YTEU
MBIGA1UECwwLU1NPUHJvdmlkZXIeXzARBGNVBAZMCMRldi03NzEyMDIxHDAABgkqhkiG9w0BCQEW
DWluZm9Ab2t0YS5jb20wHhcNMjgwNTAzMTk0MTI4WhcNMjgwNTAzMTk0MjI4WjCBKjELMAKGA1UE
BhMCVVMxExARBGNVBAZMCMkNhbG1mb3JuawExFjAUBGNVBAZMCMVNBhbiBGcmFuY2IzY28xDTALBgNV
BAoMBAE9rdGExFDASBgNVBAZMCMNTT1Byb3ZpZGVyMRMwEQYDVQDDApkZXIYtNzcXmJyAyMRwwGgYJ
KoZIHvcNAQkBFg1pbmZvQG9rdGEuY29tMIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCGKCAQEA
ugxQGqHAXpjVQZws09n818bFCoeEvH3AZbz7568XuQm6MK6h7/09wB4C5oUYddemt5t2Kc8GRhf3
BDXX5MVZ8G9AUpG1MSqe1CLV2J96rMnwMIJsKeRXr01LYxv/J4kjkntp0C389wmcY2fE4RbPoJne
P4u2b32c2/V7xsJ7UEjPPSD4i812Q6qsUkKx3AyNsjo89PekMfm+Iu/dFKXkdjwXZXPxaL0HrNW
PTpzek8NS5M5rvF8yaD+eE1zS0I/HicHbPOVvLa10JZYn/f4bp0XJkxZJz6jF5DvBkwIs8/Lz5GK
nn4XW9Cqjk3equSCJPo5o1Msj8v1LrJYVarqhwIDAQABMA0GCSqGSIb3DQEBCwUAA4IBAQC26kYe
LgqjIkF5rvxB2QzTgcd0LVzX0uiVVTZr8Sh5714jJqbDoIgvaQQrxRSQzD/X+hcmhuwdp9s8zPHS
JagtUJXiypwNtrzbF6M71trWB9sdNrqc99d1g0VRr0Kt5pLTaLe5kkq7dRaQo0IIVJhX9wgynaAK
HF/SL3mHUytjXggs88AAQa8JH9hEpwG2srN8EsizX6xwQ/p92hM2oLvK5CSMwTx4VBuGod70E0wp
6Ta1uRLQh6jCC0CWruZbbz2T3/s0X+sibC4rLiLwfyTkcUopF/bTSdWwknoRskK4dBekFcvN9N+C
```



```

        p/qaHYcQd6i2vyor888DLHDPXhSKWhpG
      </ds:X509Certificate>
    </ds:X509Data>
  </ds:KeyInfo>
</md:KeyDescriptor>
<md:NameIDFormat>urn:oasis:names:tc:SAML:1.1:nameid-format:unspecified</
md:NameIDFormat>
<md:NameIDFormat>urn:oasis:names:tc:SAML:1.1:nameid-format:emailAddress</
md:NameIDFormat>
<md:SingleSignOnService Binding="urn:oasis:names:tc:SAML:2.0:bindings:HTTP-POST"
Location="https://dev-771202.oktapreview.com/app/ibmdev771202_turbo2_1/
exkexl6xc9MhzqiC30h7/sso/saml"/>
<md:SingleSignOnService Binding="urn:oasis:names:tc:SAML:2.0:bindings:HTTP-Redirect"
Location="https://dev-771202.oktapreview.com/app/ibmdev771202_turbo2_1/
exkexl6xc9MhzqiC30h7/sso/saml"/>
</md:IDPSSODescriptor>
</md:EntityDescriptor>

```

Setting Up OpenID Authentication

According to the OpenID Foundation, "OpenID Connect 1.0 is a simple identity layer on top of the OAuth 2.0 protocol". OpenID Connect enables clients to verify user identity via a given authentication server. Turbonomic supports OpenID authentication through the following providers:

- Google
- IBM-MCM
- Okta

Logging In to Turbonomic With OpenID

When you configure OpenID in Turbonomic, the platform registers the OpenID clients that you specify. To log in through of these OpenID clients, you manually navigate to a URL that tells Turbonomic which client to use. It then redirects to the OpenID login screen for that given client.

The URL that you provide is in the form:

```
https://{hostname}/vmturbo/oauth2/authorization/{openIdClients}
```

Where:

- `{hostname}` is the host address for your installation of Turbonomic
- `{openIdClients}` is the is the client name of the OpenID provider you want to use

You specify this as the `openIdClients` property when you configure OpenID.

For example, assume your Turbonomic host address is 10.10.12.34, and you configured an Okta OpenID client. In that case, when the Turbonomic login screen appears, you would navigate to:

```
https://10.10.12.34/vmturbo/oauth2/authorization/okta
```

After you navigate to that URL, the browser redirects to the OpenID login screen, where you can enter credentials for a single user or a user group.

Note:

To authenticate a user group, the group must be configured on the OpenID provider, and also on Turbonomic. The group name must be identical in both configurations.

On the OpenID provider, the client that you are using should include groups scope values that give specific names for user groups. Contact your OpenID administrator to get the group names. Then, on Turbonomic you should create user groups that use the same names.

For example, assume the OpenID ID token includes the following groups claim:

```
{
  "sub": "1234567890",
```

```

"name": "My_User_Name",
"iat": "12121212",
"groups": "My_Special_User_Group"
}

```

To use the group `My_Special_User_Group` for authentication, you must create a user group in Turbonomic with the name `My_Special_User_Group`. Any members of that group will then get the role you have assigned to that user group.

Configuring OpenID on Turbonomic

To configure Turbonomic to authenticate via OpenID:

1. (Required) Ensure that `chrony` is configured and the system time on your Turbonomic instance is correct.

For instructions, see [Synchronizing Time](#).

2. Obtain the necessary data from your OpenID provider.

Contact your security administrator to obtain the data from the provider. You will use this data to configure SSO in the Turbonomic CR file located at:

```
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

The data you need and the properties you declare in the CR file will differ depending on the OpenID provider you want to use:

- Google:

CR Fields:	Description:
<code>openIdClients</code>	<code>google</code> The name of the OpenID client you are using to perform authentication.
<code>openIdClientId</code>	The OAuth2 Client Identifier for the OpenID client that you are using.
<code>openIdClientSecret</code>	The OAuth2 Client Secret for the OpenID client that you are using.

- IBM-MCM:

CR Fields:	Description:
<code>openIdClients</code>	<code>ibm</code> The name of the OpenID client you are using to perform authentication.
<code>openIdClientAuthentication</code>	<code>post</code> The client authentication method.
<code>openIdUserAuthentication</code>	<code>form</code> The user authentication method.
<code>openIdClientId</code>	The OAuth2 Client Identifier for the OpenID client that you are using.

CR Fields:	Description:
openIdClientSecret	The OAuth2 Client Secret for the OpenID client that you are using.
openIdAccessTokenUri	The URI the login process will use to get an Access Token.
openIdUserAuthorizationUri	The URI to the Authorization Endpoint for OpenID Connect.
openIdUserInfoUri	The URI to the OpenID Connect UserInfo endpoint.
openIdJwkSetUri	The URI to get the JSON Web Key set that can verify the Access Token.

- Okta:

CR Fields:	Description:
openIdClients	okta The name of the OpenID client you are using to perform authentication.
openIdClientId	The OAuth2 Client Identifier for the OpenID client that you are using.
openIdClientSecret	The OAuth2 Client Secret for the OpenID client that you are using.
openIdAccessTokenUri	The URI the login process will use to get an Access Token.
openIdUserAuthorizationUri	The URI to the Authorization Endpoint for OpenID Connect.
openIdUserInfoUri	The URI to the OpenID Connect UserInfo endpoint.
openIdJwkSetUri	The URI to get the JSON Web Key set that can verify the Access Token.

3. Update the Turbonomic CR file with your configuration data.

You now have the data that you need to configure SSO via OpenID. You will edit the `cr.yaml` file that configures your Turbonomic node, and then deploy or restart the node.

- Open the CR file for editing.

In a shell, `cd` to the `deploy/crds` directory in the Turbonomic VM:

```
cd /opt/turbonomic/kubernetes/operator/deploy/crds
```

Then open the CR file for editing. For example, to open the file in VI:

```
vi charts_v1alpha1_xl_cr.yaml
```

As you edit this file, you will refer to the data that you obtained from your authentication provider.

- In the CR file, navigate to the entry for the API component.

In the CR file search for or scroll to the entry:

```
apiVersion: charts.helm.k8s.io/v1alpha1
```

You will make changes to this component spec, under `spec:properties:api:`

- Turn on the OpenID feature.

For the first API property, set the following:

```
openIdEnabled: true
```

The file should be similar to:

```
apiVersion: charts.helm.k8s.io/v1alpha1
kind: X1
metadata:
  name: x1-release
spec:
  properties:
    api:
      openIdEnabled: true
```

- Enter the relevant OpenId data for your authentication provider. The CR file should be similar to these examples, depending on which provider you use:

- Google:

The file should be similar to:

```
apiVersion: charts.helm.k8s.io/v1alpha1
kind: X1
metadata:
  name: x1-release
spec:
  properties:
    api:
      openIdEnabled: true
      openIdClients: google
      openIdClientId: xxxx-4vinrdgllag5p84jjebc6xxxxxx5u.apps.googleusercontent.com
      openIdClientSecret: xxxxxhGcdFEjQa-xxxxxx
```

- IBM-MCM:

The file should be similar to:

```
apiVersion: charts.helm.k8s.io/v1alpha1
kind: X1
metadata:
  name: x1-release
spec:
  properties:
    api:
      openIdEnabled: true
      openIdClients: ibm
      openIdClientAuthentication: post
      openIdUserAuthentication: form
      openIdClientId: turbonomic-mcm-demo
      openIdClientSecret: "xxxxxxvZ2ZscDht0FVxxxxxxU3d6cXR4cTZhb2xxxxxxRT0K"
      openIdAccessTokenUri: https://icp-console.apps.blue-13.dev.multicloudops.io/
      idprovider/v1/auth/token
      openIdUserAuthorizationUri: https://icp-console.apps.blue-13.dev.multicloudops.io/
      idprovider/v1/auth/authorize
      openIdUserInfoUri: https://icp-console.apps.blue-13.dev.multicloudops.io/v1/auth/
      userInfo
      openIdJwkSetUri: https://icp-console.apps.blue-13.dev.multicloudops.io/oidc/
      endpoint/OP/jwk
```

- Okta

The file should be similar to:

```
apiVersion: charts.helm.k8s.io/v1alpha1
kind: X1
metadata:
  name: x1-release
spec:
  properties:
    api:
      openIdEnabled: true
      openIdClients: okta
      openIdClientId: xxxxxxxxxh1xhQnSKxxxx
      openIdClientSecret: xxxxxxxxxtIhVCIRUnhq4xxxxxxxDdhLdqx0
      openIdAccessTokenUri: https://vmturbo.okta.com/oauth2/v1/token
      openIdUserAuthorizationUri: https://vmturbo.okta.com/oauth2/v1/authorize
      openIdUserInfoUri: https://vmturbo.okta.com/oauth2/v1/userinfo
      openIdJwkSetUri: https://vmturbo.okta.com/oauth2/v1/keys
```

4. Save your changes to the CR file.
5. Apply the modified cr.yaml file.

Execute the command:

```
kubectl apply -f /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

6. Restart the API component to load the new spec.
 - a. Open an SSH terminal session to your Turbonomic instance.
 - b. Restart the API component.

```
kubectl delete pod api-<API_POD_ID> (NOTE: To auto-fill the pod ID, type api- and then press TAB.)
```
7. Verify that the configuration is successful.
 - a. Navigate to the Turbonomic User Interface.

You will be automatically redirected to your authentication provider for authentication.
 - b. Log in with the username that is a member of the external group or external user that you previously configured.
 - c. Verify that the system time on your Turbonomic instance is correct.

If the time is not synchronized, this might cause an HTTP Status 401 -authentication failed exception in the browser.
 - d. If the configuration is not successful, look for an HTTP Status 500 exception in the product log. If this exception exists, review your CR file for invalid entries.

Disabling Single Sign-On

If for some reason you no longer want to use SSO, you can disable it for your Turbonomic installation. To disable Single Sign-On, perform these steps:

1. Update the SSO configuration to disable it.
 - a. Open an SSH terminal session to your Turbonomic instance.
 - b. Open the CR file for editing.

In a shell, cd to the deploy/crds directory in the Turbonomic VM:

```
cd /opt/turbonomic/kubernetes/operator/deploy/crds
```

Then open the CR file for editing. For example, to open the file in VI:

```
vi charts_v1alpha1_x1_cr.yaml
```

- c. In the CR file, navigate to the entry for the API component.

In the CR file search for or scroll to the entry:

```
apiVersion: charts.helm.k8s.io/v1alpha1
```

You will make changes to this component spec, under `spec:properties:api:`

d. Turn off the SSO feature.

The entry to set to false is different depending on whether you use SAML or OpenID authentication:

- SAML Authentication:

Find the `samlEnabled:` property to false. It should appear as follows:

```
samlEnabled: false
```

- OpenID Authentication:

Find the `openIdEnabled:` property to false. It should appear as follows:

```
openIdEnabled: false
```

e. Save your changes to the CR file.

2. Restart the API component.

In the same SSH terminal session that you opened to edit the CR file:

a. Use `sudo` as root.

```
sudo bash
```

b. Restart your API component.

```
kubectl delete pod api-<API_POD_ID> (NOTE: To auto-fill the pod ID, type api- and then press TAB.)
```

3. Verify that the configuration is successful.

a. Navigate to the Turbonomic User Interface.

You will no longer be redirected to your IdP for authentication. You will be redirected to the default Turbonomic login screen.

b. Log in with a local account or an Active Directory (AD) account.

Updating Turbonomic to a New Version

Note:

If you are updating from Turbonomic version 7.21.x, or 7.17.x, please contact your Technical Support representative.

IBM continually and rapidly innovates and improves all aspects of this product. This means that IBM periodically releases newer versions of this product. You should check regularly to see if a new version is available.

When a new version is available, it is important to properly update your existing installed instance, rather than just install new VM image for the latest version. When you first installed Turbonomic, you put into place sophisticated data collection and analysis processes. Internal to the installation is an integrated database that retains performance data from across your virtual environment. Turbonomic uses this historical data for right-sizing, projecting trends, and other analysis. This means that the database is important to Turbonomic *and becomes more so over time*. Properly updating your installation of Turbonomic preserves the database for continued use.

Before you begin the update procedure:

- Review What's New for this release.

Note:

Before you perform your Turbonomic update, you should check the What's New section of the User Guide (see [What's New](#)).

As Turbonomic evolves, the set of delivered probes can change. Also, from one version to the next, the set of probes that are enabled by default can change. However, when you update to a new version, the update does not change your probe configuration. An update to a newer version does not automatically enable any new probes in your deployment. If you want to take advantage of new probes in an update, then you must enable them manually.

- Make sure you have the email that IBM sent to you with links to the Turbonomic OVA file and to the ISO image.
- For on-prem installations, make sure that the physical machine hosting the VM meets the minimum requirements (see [Minimum Requirements](#)).
- Ensure you are running the correct version of the historical database.

For its default historical database, Turbonomic currently supports MariaDB version 10.5.16. This support includes comprehensive testing and quality control for Turbonomic usage of the historical database.

For more information, see [Verifying your MariaDB Version](#).

- Execute the `upgrade-precheck.sh` script.

You can use this script to make sure that your current installation of Turbonomic is ready to update. We strongly recommend that you run this script before going on to update your installation (see [Checking Before Updating](#)).

You can update your Turbonomic VM using either of the following methods:

- Online method, if you have access to the internet:

See [Online Update](#)

- Offline method, via a downloaded ISO image:

See [Offline Update](#)

Checking Before Updating

Before you perform an update of your Turbonomic instance, you should execute the script, `upgrade-precheck.sh`. This script inspects your installation to check for the following:

- Sufficient free disk space
- For online updates, access to required endpoints (`index.docker.io`, `github.com`, etc.)
- The MariaDB service is running

Note that this check is for the default installation of the MariaDB service, only. For example, the script does not check an external installation of MySQL or MariaDB, if that is the historical database you have configured. In that case, the script will indicate that your MariaDB service is not running. For an external database deployment, this is a normal result.

- The Kubernetes service is running
- The necessary Kubernetes certificates are valid

If the certificates are not valid, you can run the `kubeNodeCertUpdate.sh` script to correct the issue. This script should be located on your installation at `/opt/local/bin`. For more information, contact your support representative.

- Root password is not set to expire
- Time sync is enabled, and current if running
- All Turbonomic pods are running

To execute this script:

1. Download the latest version of the script.

- a. Log in to the Turbonomic VM.

Use SSH to log in to the Turbonomic VM using the turbo account and password.

- b. Change to the scripts directory.

```
cd /opt/local/bin
```

- c. Get the latest version of the script.

```
curl -O --proxy PROXY_NAME_IP:PORT \  
https://\  
raw.githubusercontent.com/turbonomic/t8c-install/master/bin/upgrade-precheck.sh
```

Where `--proxy PROXY_NAME_IP:PORT` is an optional specification to execute the download through a proxy.

- d. Save the script to the location:

```
/opt/local/bin/upgrade-precheck.sh
```

- e. Make the script executable.

```
chmod +x upgrade-precheck.sh
```

2. Execute the script.

```
./upgrade-precheck.sh
```

As the script executes, it identifies any issues that you should address before you execute an update.

External DBs and Turbonomic Updates

If you have deployed Turbonomic with an external database server, for some updates you might need to manually create a new database and user for that deployment. This is important if your external database server is multi-tenant, or if your deployment does not grant administrative privileges to Turbonomic.

Note:

If your external database server is multi-tenant, or if your database server does not grant administrative privileges to Turbonomic, then you must continue with this configuration requirement.

Azure database services are multi-tenant. If you deployed an external database on Azure, this configuration requirement applies to you.

If you deployed your database server in a way that grants Turbonomic privileges to create new databases and new users, then a product update will automatically create the required database. This configuration requirement does not apply to you and you do not need to take any action.

For some Turbonomic updates, the updated version includes new databases on the historical database server. If you are updating to one of these versions, then you must *first* create the new database, and a user account with privileges to access that database.

This table lists the Turbonomic versions that require new databases. If you are updating from a version earlier than one of these, you must create the indicated new databases. For example, if you are updating from version 8.0.0 to 8.2.0, then you must create the `repository` database and the `market` database.

Turbonomic Version:	New Databases:	Notes:
8.2.5	api	If you are updating from a version earlier than 8.2.5, you must create a new database named <code>api</code> , and a user account named <code>api</code> .

Turbonomic Version:	New Databases:	Notes:
8.1.1	market	If you are updating from a version earlier than 8.1.1, you must create a new database named <code>market</code> , and a user account named <code>market</code> .
8.0.1	repository	If you are updating from a version earlier than 8.0.1, you must create a database named <code>repository</code> , and a user account named <code>repository</code> .

Note:

If you have already updated to one of these versions of Turbonomic, and you did not perform the steps to update your external DB, please contact your support representative.

To create the databases and users, you will:

- Manually create each required database

This includes creating the database in your DB instance, creating a user to access the database, and granting privileges to the user.

- Manually add the each required database to your `cr.yaml` file

The `cr.yaml` file declares entries for each component database. Each entry names the component, and gives the user and password that the component can use to access that database. You must add a new entry for each new database.

To create a new database:

1. Connect to your external DB using a global account.

The account must have privileges to create databases and users. If you have specified `dbRootUsername` in the `cr.yaml` file, you can use that account.

2. Create the database, where **<New_Database>** matches the database name in the table above:

```
create database <New_Database>;
```

For example, to create a new `api` database, execute:

```
create database api;
```

3. Create the account that Turbonomic will use to access the database where **<New_Database>** matches the database name in the table above:

```
create user '<New_Database>'@'%' identified by 'vmturbo';
```

For example, to create a user for the `api` database, execute:

```
create user 'api'@'%' identified by 'vmturbo';
```

Note:

The value **vmturbo** is the default password that Turbonomic uses for all component database accounts. If you have manually created accounts with different credentials, you can do so for this database as well.

4. Set the user account privileges for the new user account, where **<New_Database>** matches the database name in the table above:

```
GRANT SELECT, INSERT, UPDATE, DELETE, CREATE, DROP, REFERENCES, INDEX, ALTER, CREATE  
TEMPORARY TABLES, LOCK TABLES, EXECUTE, CREATE VIEW, SHOW VIEW, CREATE ROUTINE, ALTER  
ROUTINE, EVENT, TRIGGER ON <New_Database>.* TO '<New_Database>'@'%' ;
```

For example, to set account privileges for the api user, execute:

```
GRANT SELECT, INSERT, UPDATE, DELETE, CREATE, DROP, REFERENCES, INDEX, ALTER, CREATE
TEMPORARY TABLES, LOCK TABLES, EXECUTE, CREATE VIEW, SHOW VIEW, CREATE ROUTINE, ALTER
ROUTINE, EVENT, TRIGGER ON api.* TO 'api'@'%';
```

5. Flush privileges to make the privileges take effect:

```
flush privileges;
```

Now that the new database is created in your external DB service, you must declare access to it the Turbonomic cr.yaml resource.

1. Open the .cr file for editing. The location of the file depends on the type of Turbonomic installation you are configuring.

VM Image installation of Turbonomic:	Turbonomic on a Kubernetes node or node cluster:
<p>Open a SSH terminal session on your Turbonomic instance</p> <p>Log in with the System Administrator that you set up when you installed Turbonomic:</p> <ul style="list-style-type: none">• Username: turbo• Password: [your_private_password] <p>Then edit the file:</p> <pre>/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml</pre>	<p>Open the following file for editing:</p> <pre>deploy/crds/charts_v1alpha1_xl_cr.yaml</pre>

2. Add the credentials for the matching pod to access the new database.

Add the entry to the `properties:` section of the `cr.yaml` file, where **vmturbo** is the password that you assigned to that user account, **yourDB** is the qualified name of your external DB or your multi-tenant DB partition, and **<New_Database>** is the name of your new database. Declare the following in the entry you add:

```
<New_Database>:
  <New_Database>DbUsername: <New_Database>@yourDB
  <New_Database>DbPassword: vmturbo
```

For example, if you added the api database, the resulting `cr.yaml` file should be similar to:

```
properties:
  global:
    enableSecureDBConnection: true
    sqlDialect: MYSQL
    dbRootPassword: yourAdminPassword
    dbRootUsername: xladmin@yourDB
    #dbUserPassword:
    #dbUsername:
  action-orchestrator:
    actionDbUsername: action@yourDB
    actionDbPassword: yourPassword
  auth:
    authDbUsername: auth@yourDB
    authDbPassword: yourPassword
  clustermgr:
    clustermgrDbUsername: clustermgr@yourDB
    clustermgrDbPassword: yourPassword
  cost:
    costDbUsername: cost@yourDB
    costDbPassword: yourPassword
  group:
    groupComponentDbUsername: group_component@yourDB
    groupComponentDbPassword: yourPassword
```

```

history:
  historyDbUsername: history@yourDB
  historyDbPassword: yourPassword
plan-orchestrator:
  planDbUsername: plan@yourDB
  planDbPassword: yourPassword
topology-processor:
  topologyProcessorDbUsername: topology_processor@yourDB
  topologyProcessorDbPassword: yourPassword
repository:
  repositoryDbUsername: repository@yourDB
  repositoryDbPassword: yourPassword
market:
  marketDbUsername: market@yourDB
  marketDbPassword: yourPassword
api:
  apiDbUsername: api@yourDB
  apiDbPassword: yourPassword

```

After you have done this, you can update to the latest version of Turbonomic. (Note that upgrading applies changes to the version information in this file.)

Online Update

Online updates assume that you have direct access to the Internet or access to the Internet through a proxy server.

Connection Requirements

If you are installing from behind a firewall, make sure you have full access to the Docker Hub services that deliver the Turbonomic components. Addressing for these services can be different depending on details of your current environment. Note that IBM has no control over these endpoints. As of this writing, we can say you need access to the following:

- <https://index.docker.io>
- <https://auth.docker.io>
- <https://registry-1.docker.io>
- <https://production.cloudflare.docker.com>
- <https://raw.githubusercontent.com>
- <https://github.com>
- <https://download.vmturbo.com>
- <https://yum.mariadb.org>
- <https://packagecloud.io>
- <https://download.postgresql.org>
- <https://yum.postgresql.org>

If your environment supports access through a proxy, you can set up the Docker daemon to use that proxy via the HTTP_PROXY, HTTPS_PROXY, and NO_PROXY environment variables. Create the file:

```
/etc/systemd/system/docker.service.d/http-proxy.conf
```

Configure the proxies in the [Service] section of the file, where NO_PROXY specifies hosts to exclude from proxying:

```
[Service]
Environment="HTTP_PROXY=http://proxy.example.com:80"
Environment="HTTPS_PROXY=https://proxy.example.com:443"
Environment="NO_PROXY=localhost,127.0.0.1,docker-registry.example.com,.corp"
```

Then reload the daemon and restart Docker:

```
sudo systemctl daemon-reload
sudo systemctl restart docker
```

For more information, see the Docker documentation at <https://docs.docker.com/config/daemon/systemd/>

If none of these options work, then you should perform an offline update.

Performing an Online Update

To perform an online update of your Turbonomic installation:

1. Download the current update script.

You must download the update script that matches the version you are updating to.

Note:

Scripted online updates support updates to version 8.0.6 or later.

- a. Log in to the Turbonomic VM.

Use SSH to log in to the Turbonomic VM using the turbo account and password.

- b. Change to the scripts directory.

```
cd /opt/local/bin
```

- c. Get the script for your update version.

```
curl -O --proxy PROXY_NAME_IP:PORT \
https://download.vmturbo.com/appliance/download/updates/{VNUM}/onlineUpgrade.sh
```

Where:

- --proxy PROXY_NAME_IP:PORT is an optional specification to execute the download through a proxy.
- {VNUM} is the version you are updating to. The version must be 8.0.6 or later.

- d. Save the script to the location:

```
/opt/local/bin/onlineUpgrade.sh
```

- e. Make the script executable.

```
chmod +x onlineUpgrade.sh
```

2. Save a snapshot of your current Turbonomic VM.

Before updating, you should properly shut down (not power off) the Turbonomic VM. To do so, type:

```
sudo init 0
```

Then, perform a snapshot (or clone the VM). This provides a reliable restore point you can turn to in the event that trouble occurs during the update. After you have the snapshot, bring the VM back online.

3. Optionally, enable new probes in your environment.

Note:

Before you perform your Turbonomic update, you should check the What's New section of the User Guide (see [What's New](#)).

As Turbonomic evolves, the set of delivered probes can change. Also, from one version to the next, the set of probes that are enabled by default can change. However, when you update to a new version, the update does not change your probe configuration. An update to a newer version does not automatically enable any new probes in your deployment. If you want to take advantage of new probes in an update, then you must enable them manually.

To enable new probes:

- a. Open an SSH terminal session on your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username:

```
turbo
```

- Password:

```
[your_private_password]
```

- b. Display the list of available probes.

```
cat /opt/turbonomic/kubernetes/operator/helm-charts/x1/values.yaml
```

The results should be similar to:

```
customdata:
  enabled: false
dynatrace:
  enabled: false
gcp:
  enabled: false
hpe3par:
  enabled: false
...
```

This list gives the internal names of the probes. If you want to add a new probe to your list of configured probes, you must use the internal name, and set `enabled: true`.

- c. In the SSH session, open the `cr.yaml` file for editing. For example:

```
vi /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

- d. Edit the probe entries.

Find the probes you want to enable and change their settings to `enabled: true`.

To add new probes to the list, copy the probe entry you want from the output when you used `cat` to view the available probes. Then paste that entry into the `cr.yaml` file and set `enabled: true`.

- e. When you have made your changes, save the `charts_v1alpha1_x1_cr.yaml` file.

Note:

You should not use `via kubectl` to apply these changes at this time.

4. Start the online update.

Execute the update script:

- If you are not already in the `/opt/local/bin` directory:

```
cd /opt/local/bin
```

- Execute the update script:

```
./onlineUpgrade.sh {Update_Version}
```

Where **{Update_Version}** is the version you are updating to.

Note:

Be sure that you give the version that you are updating to, and be sure that it matches the version of the update script that you downloaded.

Also, you cannot use this script to move to an earlier version.

- Wait until the script completes its execution.

5. Verify that the Turbonomic application installed correctly.

To verify the installation of the application, execute the command:

```
kubectl get pods -n turbonomic
```

After all of the pods start up, the READY column should read 1/1 and the STATUS column should read Running for each pod.

Note:

Under rare circumstances the downloads from DockerHub can fail. This occurs when the limit on image downloads has been exceeded. As a result, one or more pods can show ImagePullBackOff as the pod STATUS.

If you encounter this STATUS, you can wait until the limitation period expires. At that time, the download of pods will continue, and the platform should start up normally.

As an alternative, you can register your own DockerHub account in the CR file, and apply those changes:

- Edit the registry in the cr.yaml file:

```
registry: index.docker.io
imageUsername: Your_Username
imagePassword: Your_User_Password
```

- Execute the kubectl apply command:

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

- Verify that the application installed correctly:

```
kubectl get pods -n turbonomic
```

6. Verify that you are running the correct version of MariaDB.

For this version of the product, Turbonomic supports MariaDB, version 10.5.16. Even after updating to this Turbonomic version, it is possible that your installation is running an earlier version of MariaDB.

While still in the SSH session, check the MariaDB version:

```
mysql -u root --password=my_pwd -e "SHOW VARIABLES LIKE 'version';"
```

The output should be similar to:

```
+-----+-----+
| Variable_name | Value                |
+-----+-----+
| version       | 10.5.16-MariaDB     |
+-----+-----+
```

If the MariaDB version is earlier than 10.5.16, you should update your MariaDB. For complete instructions and information, see [Verifying your MariaDB Version](#).

7. Clear your browser data and refresh your browser.

After clearing the browser data and refreshing your browser, you have full access to Turbonomic features. However, features that rely on current analysis data will not be available until after a full market cycle — usually 10 minutes. For example, the Pending Actions charts will not show any actions until after a full market cycle.

8. Notify other users to clear their browser data and refresh their Turbonomic browser sessions.

Offline Update

To perform an offline update of your Turbonomic installation:

1. Save a snapshot of your current Turbonomic VM.

Before updating, you should properly shut down (not power off) the Turbonomic VM. To do so, type:

```
sudo init 0
```

Then, perform a snapshot (or clone the VM). This provides a reliable restore point you can turn to in the event that trouble occurs during the update. After you have the snapshot, bring the VM back online.

2. Download and mount the ISO image.

Refer to the email you received from IBM for links to the Turbonomic OVA file and to the ISO image.

Download the ISO image to a location that is available to the VM that runs Turbonomic. Then mount the image as a CD drive.

For example, if you run the Turbonomic VM in vCenter Server:

- a. In vCenter, navigate to the Turbonomic VM.
 - b. Right-click the VM and choose **Edit Settings**.
 - c. In the CD/DVD Drive drop-down menu:
 - i) Choose **Datastore ISO**.
 - ii) Browse to the Turbonomic update ISO image and choose it.
 - d. Ensure that the **Connect at power on** checkbox is selected.
3. Open an SSH terminal session to your Turbonomic instance.

After you have made a snapshot or clone of your current Turbonomic VM, open an SSH session. Log in with the System Administrator that you set up when you installed Turbonomic:

 - Username: `turbo`
 - Username: `[your_private_password]`
 4. Get the script for your update version.

On your local machine, navigate to where you want to download the script. Then execute the command:

```
curl -O --proxy PROXY_NAME_IP:PORT \
https://download.vmturbo.com/appliance/download/updates/{VNUM}/isoUpdate.sh
```

Where:

- `--proxy PROXY_NAME_IP:PORT` is an optional specification to execute the download through a proxy.
 - `{VNUM}` is the version you are updating to. The version must be 8.2.5 or later.
5. Upload the script to your Turbonomic instance.

Execute a file transfer from your local machine to the Turbonomic server. Save the script to `/opt/local/bin/` on the VM that runs Turbonomic.

6. Make the script executable.

```
chmod +x /opt/local/bin/isoUpdate.sh
```

7. Execute the offline installation.

```
/opt/local/bin/isoUpdate.sh
```

As the script executes, it:

- Backs up the old scripts in your installation
- Updates the configuration and code assets in your installation
- Updates the platform to the new version
- Updates custom resources
- Updates the MariaDB configuration (but this does *not* update the MariaDB version)
- If you have enabled Embedded Reports or Data Export, installs the Embedded Reports and Data Export database (Postgres and TimescaleDB)
- Scales down the t8c-operator and the Turbonomic components
- Executes the final updates for this version
- Scales up the t8c-operator, which then restarts the Turbonomic components

8. Verify that the Turbonomic application installed correctly.

After the script is finished updating your platform, you should give it enough time for all the components to start up again.

To verify the installation of the application, execute the command:

```
kubectl get pods -n turbonomic
```

After all of the pods start up, the READY column should read 1/1 and the STATUS column should read Running for each pod.

You should see output similar to the following:

NAME	READY	STATUS	RESTARTS
action-orchestrator-b6454c9c8-mfl85	1/1	Running	0
api-7887c66f4b-shndq	1/1	Running	0
arangodb-7f646fc5fc-zhchw	1/1	Running	0
auth-5b86976bc8-vxwz4	1/1	Running	0
clustermgr-85548678d9-r5wb8	1/1	Running	0
consul-7f684d8cb8-6r677	1/1	Running	0
cost-5f46dd66c4-6d6cb	1/1	Running	0
extractor-5f41dd61c4-4d6lq	1/1	Running	0
group-5bfd6bc6f8-96bsp	1/1	Running	0
history-5fc7fbc855-6zslq	1/1	Running	0
kafka-74cc77db94-dfibr	1/1	Running	0
market-5f54699447-z4wkm	1/1	Running	0
mediation-actionscript-57b4fc6df-4lzfz	1/1	Running	0
mediation-appdynamics-6d65f8766f-kb44l	1/1	Running	0
mediation-hpe3par-d7c475c4c-v8ftc	1/1	Running	0
mediation-hyperv-6bd8c94df5-4dbzx	1/1	Running	0
mediation-netapp-7f8fc955d9-4kkdl	1/1	Running	0
mediation-oneview-7dbd7b54cf-7rfqp	1/1	Running	0
mediation-pure-58c4bd8cd9-8n256	1/1	Running	0
mediation-ucs-6f4bb9889-9rnqk	1/1	Running	0
mediation-vccenter-5bc4f5fbd4-nzm4j	1/1	Running	0
mediation-vccenterbrowsing-5c5987f66c-bfjq4	1/1	Running	0
mediation-vmx-6c59969b89-28t9j	1/1	Running	0
mediation-vmv-9c4878cf9-rfxnl	1/1	Running	0
nginx-5b775f498-sm2mm	1/1	Running	0
plan-orchestrator-6dffc4c9b6-p5t5n	1/1	Running	0
reporting-b44fbd6b4-8fjv5	1/1	Running	0
repository-6d555bb4bf-fxldh	1/1	Running	0
rsyslog-fd694878c-5tb2c	1/1	Running	0
t8c-operator-558bcc758d-5h8mp	1/1	Running	0
topology-processor-b646b786b-9skp7	1/1	Running	0
zookeeper-5f65b5bf69-nnmbt	1/1	Running	0

9. Verify that you are running the correct version of MariaDB.

For this version of the product, Turbonomic supports MariaDB, version 10.5.16. Even after updating to this Turbonomic version, it is possible that your installation is running an earlier version of MariaDB.

While still in the SSH session, check the MariaDB version:

```
mysql -u root --password=my_pwd -e "SHOW VARIABLES LIKE 'version';"
```

The output should be similar to:

```
+-----+-----+
| Variable_name | Value               |
+-----+-----+
| version       | 10.5.16-MariaDB    |
+-----+-----+
```

If the MariaDB version is earlier than 10.5.16, you should update your MariaDB. For complete instructions and information, see [Verifying your MariaDB Version](#).

10. Clear your browser data and refresh your browser.

After clearing the browser data and refreshing your browser, you have full access to Turbonomic features. However, features that rely on current analysis data will not be available until after a full market cycle — usually 10 minutes. For example, the Pending Actions charts will not show any actions until after a full market cycle.

11. Optionally, enable new probes in your environment.

Note:

Before you perform your Turbonomic update, you should check the What's New section of the User Guide (see [What's New](#)).

As Turbonomic evolves, the set of delivered probes can change. Also, from one version to the next, the set of probes that are enabled by default can change. However, when you update to a new version, the update does not change your probe configuration. An update to a newer version does not automatically enable any new probes in your deployment. If you want to take advantage of new probes in an update, then you must enable them manually.

For steps to enable new probes in your updated version, see [Enabling and Disabling Probe Components](#). Use these steps to edit the platform's `cr.yaml` file, and then apply those changes via `kubectl`.

12. Notify other users to clear their browser data and refresh their Turbonomic browser sessions.

Appendix: What Are the Typical Settings for an IdP?

Before you begin configuring Single Sign-On (SSO), you need to make sure the IdP is set up for SSO.

Here are typical settings for a public Okta IdP which may be useful when you set up your IdP.

SAML Settings: GENERAL	
Setting	Example
Single Sign On URL (where <hostname> is the host that Turbonomic runs on, and <samlRegistrationID> is the Registration ID that you got from your SSO provider)	<code>https://<hostname>/vmturbo/saml2/sso/<samlRegistrationID></code>

SAML Settings: GENERAL		
Setting	Example	
Recipient URL (where <hostname> is the host that Turbonomic runs on, and <samlRegistrationID> is the Registration ID that you got from your SSO provider)	https:// <hostname> /vmturbo/saml2/sso/ <samlRegistrationID>	
Destination URL (where <hostname> is the host that Turbonomic runs on, and <samlRegistrationID> is the Registration ID that you got from your SSO provider)	https:// <hostname> /vmturbo/saml2/sso/ <samlRegistrationID>	
Audience Restriction	urn:test:turbo:markharm	
Default Relay State		
Name ID Format	Unspecified	
Application username	The username for the account that is managed by Okta	
Response	Signed	
Assertion Signature	Signed	
Signature Algorithm	RSA_SHA256	
Digital Algorithm	SHA256	
Assertion Encryption	Unencrypted	
SAML Single Logout	Enabled	
Single Logout URL (where <hostname> is the host that Turbonomic runs on)	https:// <hostname> /vmturbo/rest/logout	
SP Issuer	turbo	
Signature Certificate	Example.cer (CN=apollo)	
authnContextClassRef	PasswordProtectedTransport	
Honor Force Authentication	Yes	
SAML Issuer ID	http://www.okta.com/\$(org.externalKey)	
SAML Settings: GROUP ATTRIBUTE STATEMENTS		
Name	Name Format	Filter
group	Unspecified	Matches regex:.*admin.*.

Appendix: FIPS Cipher Suites

The Federal Information Processing Standard (FIPS) is in place to ensure the cryptographic strength of secure connections. By default, Turbonomic ships with a FIPS-compliant cipher suite already enabled. The suite comprises the following ciphers:

- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA
- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256
- TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA
- TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384
- TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384
- TLS_ECDHE_RSA_WITH_ARIA_128_GCM_SHA256
- TLS_ECDHE_RSA_WITH_ARIA_256_GCM_SHA384

Modifying the Cipher Suite

If necessary, you can modify the cipher suite to comply with your internal policies.

1. Open an SSH terminal session on your Turbonomic instance.

Log in with the System Administrator that you set up when you installed Turbonomic:

- Username:

```
turbo
```

- Password:

```
[your_private_password]
```

2. In the SSH session, open the `cr.yaml` file for editing. For example:

```
vi /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

3. Edit the cipher suite.

Search for the list of ciphers in the file. Change the list as your policies require, and then save the file.

4. Apply your changes to the platform.

```
kubectl apply -f \
/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_x1_cr.yaml
```

Appendix: Step-wise Platform Deployment

After you have installed the Turbonomic VM that will host the platform, you can install the platform components, as follows:

1. Optionally, configure Single Sign-On Authentication (SSO) for this installation.

If you plan to use SSO to authenticate your Turbonomic users, you can configure it now. To configure SSO you will edit the `charts_v1alpha1_x1_cr.yaml` file. You can edit it now, before you complete the installation, or you can edit it later and restart the affected components. For more information, see [Single Sign-On Authentication](#).

2. Deploy Turbonomic Kubernetes nodes.

When you deploy Turbonomic on Kubernetes, you deploy one Kubernetes node as a VM that will host pods to run the Turbonomic components. The script to deploy and initialize the Kubernetes node also deploys the Kubernetes pods that make up the Turbonomic application.

Start a secure session (SSH) on your Turbonomic VM as the turbo user and perform the following steps:

- a. Initialize the Kubernetes node and deploy the pods.

Execute the script: `/opt/local/bin/t8c.sh`

Do not specify `sudo` when you execute this script.

The script should take up to 20 minutes to complete.

Note:

You can specify the host name for the Turbonomic deployment.

By default, the Turbonomic platform deploys to a host named `node1`. To specify a different host name, execute the script with the `-h` flag as follows:

```
/opt/local/bin/t8c.sh -h <MyHostName>
```

Where `<MyHostName>`:

- Consists of lower-case alphanumeric characters, `.`, or `-`
- Begins and ends with an alphanumeric character

Also note that after you change the hostname, you must reboot the VM for the name change to take effect.

- b. Verify that the deployment succeeded.

At the end of the script output, in the summary section, verify that no errors are reported. If any errors are reported, contact Turbonomic Support.

- c. Verify that the Turbonomic application installed correctly.

To verify the installation of the application, execute the command:

```
kubectl get pods -n turbonomic
```

After all of the pods start up, the `READY` column should read `1/1` and the `STATUS` column should read `Running` for each pod.

You should see output similar to the following:

NAME	READY	STATUS	RESTARTS
action-orchestrator-b6454c9c8-mfl85	1/1	Running	0
api-7887c66f4b-shndq	1/1	Running	0
arangodb-7f646fc5fc-zhcwf	1/1	Running	0
auth-5b86976bc8-vxwz4	1/1	Running	0
clustermgr-85548678d9-r5wb8	1/1	Running	0
consul-7f684d8cb8-6r677	1/1	Running	0
cost-5f46dd66c4-6d6cb	1/1	Running	0
extractor-5f41dd61c4-4d6lq	1/1	Running	0
group-5bfd6bc6f8-96bsp	1/1	Running	0
history-5fc7fbc855-6zslq	1/1	Running	0
kafka-74cc77db94-dfrbl	1/1	Running	0
market-5f54699447-z4wkm	1/1	Running	0
mediation-actionscript-57b4fc6df-4lzfv	1/1	Running	0
mediation-appdynamics-6d65f8766f-kb44l	1/1	Running	0
mediation-hpe3par-d7c475c4c-v8ftc	1/1	Running	0
mediation-hyperv-6bd8c94df5-4dbzx	1/1	Running	0
mediation-netapp-7f8fc955d9-4kkdl	1/1	Running	0
mediation-oneview-7dbd7b54cf-7rfqp	1/1	Running	0
mediation-pure-58c4bd8cd9-8n256	1/1	Running	0
mediation-ucs-6f4bb9889-9rnqk	1/1	Running	0
mediation-vcenter-5bc4f5fbd4-nzm4j	1/1	Running	0
mediation-vcenterbrowsing-5c5987f66c-bfjq4	1/1	Running	0
mediation-vmax-6c59969b89-28t9j	1/1	Running	0
mediation-vmware-9c4878cf9-rfxnl	1/1	Running	0
nginx-5b775f498-sm2mm	1/1	Running	0
plan-orchestrator-6dffc4c9b6-p5t5n	1/1	Running	0
reporting-b44fbdfb4-8fjv5	1/1	Running	0
repository-6d555bb4bf-fxldh	1/1	Running	0
rsyslog-fd694878c-5tb2c	1/1	Running	0
t8c-operator-558bcc758d-5h8mp	1/1	Running	0

topology-processor-b646b786b-9skp7	1/1	Running	0
zookeeper-5f65b5bf69-nnmbt	1/1	Running	0

d. Synchronize the system clock.

To ensure correct display of data, and to support Single Sign-On (SSO) authentication, you need to synchronize the system clock.

For information, see [Synchronizing Time](#) and [Single Sign-On Authentication](#).

e. Verify that the Load Balancer has installed correctly.

To verify the presence of the Load Balancer, execute the command:

```
kubectl get services -n turbonomic | grep LoadBalancer
```

You should see output similar to the following:

nginx	LoadBalancer	10.10.10.10	10.10.10.11	443:32669/TCP,80:32716/TCP	17h
-------	--------------	-------------	-------------	----------------------------	-----

f. Configure mediation.

The installation script automatically enables a default set of mediation probes. After installation completes, you can change the set of enabled mediation probes (see [Enabling and Disabling Probe Components](#)).

For Turbonomic to manage your IT environment, it must attach to targets in your environment so it can perform discovery and execute actions. The combination of the processes of discovery and action execution is *mediation*. This release of Turbonomic supports mediation through the following targets. If you need to use additional targets that are not in this list, contact Turbonomic Support.

- Applications and Databases
 - Apache Tomcat 7.x, 8.x, and 8.5.x
 - AppDynamics 4.1+
 - AppInsights
 - Dynatrace 1.1+
 - IBM WebSphere Application Server 8.5+
 - Instana, release-209 or later
 - JBoss Application Server 6.3+
 - JVM 6.0+
 - Microsoft SQL Server 2012, 2014, 2016, 2017, and 2019
 - MySQL 5.6.x and 5.7.x
 - NewRelic
 - Oracle 11g R2, 12c, 18c, and 19c
 - Oracle WebLogic 12c
- Cloud Native
 - Kubernetes, including any compliant k8s distribution (Rancher, Tanzu, open source, etc.)
 - Cloud-hosted k8s services (AKS, EKS, GKE, IBM, Cisco IKS, ROKS, ROSA, etc.)
 - OpenShift 3.11 and higher (OCP 4.x)
- Fabric and Network
 - Cisco UCS Manager 3.1+
 - HPE OneView 3.00.04
- Guest OS Processes
 - SNMP

- WMI: Windows versions 8 / 8.1, 10, 2008 R2, 2012 / 2012 R2, 2016, 2019 and 7
- Hyperconverged
 - Cisco HyperFlex 3.5
 - Nutanix Community Edition
 - VMware vSAN
- Hypervisors
 - Microsoft Hyper-V 2008 R2, Hyper-V 2012/2012 R2, Hyper-V 2016, Hyper-V 2019
 - VMware vCenter 6.0, 6.5, 6.7, and 7.0+
- Orchestrator
 - Action Script
 - Flexera One
 - ServiceNow
- Private Cloud
 - Microsoft System Center 2012/2012 R2 Virtual Machine Manager and System Center 2016 Virtual Machine Manager
- Public Cloud
 - Amazon AWS
 - Amazon AWS Billing
 - Google Cloud Platform (GCP)
 - Google Cloud Platform (GCP) Billing
 - Microsoft Azure Service Principal
 - Microsoft Enterprise Agreement
- Storage
 - EMC ScaleIO 2.x and 3.x
 - EMC VMAX using SMI-S 8.1+
 - EMC VPLEX Local Architecture with 1:1 mapping of virtual volumes and LUNs
 - EMC XtremIO XMS 4.0+
 - HPE 3PAR InForm OS 3.2.2+, 3PAR SMI-S, 3PAR WSAPI
 - IBM FlashSystem running on Spectrum Virtualize 8.3.1.2 or later (8.4.2.0 or later recommended)
 - NetApp Cluster Mode using ONTAP 8.0+ (excluding AFF and SolidFire)
 - Pure Storage F-series and M-series arrays
- Virtual Desktop Infrastructure
 - VMware Horizon

For information about these targets, see the *Turbonomic Target Configuration Guide*.

3. Log in to the Turbonomic user interface and set the administrator user account password.

Important:

You should wait until all the platform components have started up, are running, and are fully ready before your first login. If you try to add a license or add a target to the platform before the components are all ready, the platform can fail to initialize correctly. For more information, see [Verify that the Turbonomic application installed correctly](#).

After the components start up, in your Web browser, type the static IP address of your Turbonomic VM. Your browser redirects the login page for Turbonomic users.

Turbonomic includes a default user account named `administrator` which has an `ADMINISTRATOR` role. As you log in for the first time, you must set your own password for that account. You can create or delete other accounts with the `ADMINISTRATOR` role, but your installation of Turbonomic must always have at least one account with that role.

In the login page, enter the information as required, and make a note of it.

- Use the default credential for **USERNAME**: `administrator`.
- Type a password for **PASSWORD**.

The new password must comply with the strong password policy (a mixture of upper- and lower-case letters, numbers, and a symbol). Only you will know this new password.

- Type the password again to verify it for **REPEAT PASSWORD**.
- Click **CONFIGURE**.

This is the account you will use to access the Turbonomic user interface with `administrator` permissions. *Be sure to save the user interface administrator account credentials in a safe place.*

Note:

The initial login is always for the `administrator` account. This is an administration *user* account. Do not confuse this with the Turbonomic System Administrator account that you previously set up to log into shell sessions on the VM itself.

4. After you have logged in as `administrator`, you can create other user accounts, and you can give them various roles. For more information about user accounts and roles, see the *Turbonomic User Guide*.

Appendix: Step-wise Offline Update

To perform a stepwise offline update of your Turbonomic installation:

1. Save a snapshot of your current Turbonomic VM.

Before updating, you should properly shut down (not power off) the Turbonomic VM. To do so, type:

```
sudo init 0
```

Then, perform a snapshot (or clone the VM). This provides a reliable restore point you can turn to in the event that trouble occurs during the update. After you have the snapshot, bring the VM back online.

2. Download and attach the ISO image to the VM that runs Turbonomic.

Refer to the email you received from IBM for links to the Turbonomic OVA file and to the ISO image.

3. Mount the ISO image by logging in to vCenter.

- a. In vCenter, navigate to the Turbonomic VM.
- b. Right-click the VM and choose **Edit Settings**.
- c. In the CD/DVD Drive drop-down menu:
 - i) Choose **Datastore ISO**.
 - ii) Browse to the Turbonomic update ISO image and choose it.
- d. Ensure that the **Connect at power on** checkbox is selected.

4. Log in to the Turbonomic VM.

Use SSH to log in to the Turbonomic VM using the `turbo` account and password.

5. Mount the ISO image.

Type:

```
sudo mount /dev/cdrom /mnt/iso
```

6. Verify the correct version of the ISO image is mounted.

Type: `ls /mnt/iso`

Verify that the ISO image contains the correct version for your update.

7. Load the latest Docker images.

Type: `sudo /mnt/iso/turboinstall.sh`

This script loads all the images to the Turbonomic instance. If the load is successful, it displays a message similar to:

```
The t8c upgrade iso has been mounted
Image check:
=====
*****
All images have been loaded
*****
```

If the load does not succeed, the script will list any images that did not load, along with instructions to load them manually.

8. Execute these commands to update Turbonomic.

- `/mnt/iso/turboupgrade.sh | tee \`
`/opt/turbonomic/t8c_upgrade_$(date +%Y-%m-%d_%H_%M_%S).log`

Wait until the script is finished.

9. Verify that you are running the correct version of MariaDB.

For this version of the product, Turbonomic supports MariaDB, version 10.5.16. Even after updating to this Turbonomic version, it is possible that your installation is running an earlier version of MariaDB.

While still in the SSH session, check the MariaDB version:

```
mysql -u root --password=my_pwd -e "SHOW VARIABLES LIKE 'version';"
```

The output should be similar to:

Variable_name	Value
version	10.5.16-MariaDB

If the MariaDB version is earlier than 10.5.16, you must update your MariaDB. For complete instructions and information, see [Verifying your MariaDB Version](#).

10. Unmount the ISO image.

Enter the command:

```
sudo umount /dev/cdrom
```

11. Clear your browser data and refresh your browser.

After clearing the browser data and refreshing your browser, you have full access to Turbonomic features. However, features that rely on current analysis data will not be available until after a full market cycle — usually 10 minutes. For example, the Pending Actions charts will not show any actions until after a full market cycle.

12. Optionally, enable new probes in your environment.

Note:

Before you perform your Turbonomic update, you should check the What's New section of the User Guide (see [What's New](#)).

As Turbonomic evolves, the set of delivered probes can change. Also, from one version to the next, the set of probes that are enabled by default can change. However, when you update to a new version, the update does not change your probe configuration. An update to a newer version does not automatically enable any new probes in your deployment. If you want to take advantage of new probes in an update, then you must enable them manually.

For steps to enable new probes in your updated version, see [Enabling and Disabling Probe Components](#). Use these steps to edit the platform's cr.yaml file, and then apply those changes via `kubectl`.

13. Optionally, enable Turbonomic on Turbonomic.

For updates from versions earlier than 7.22.4

In Turbonomic, the supply chain can model your deployment as a Business Application. For updates from versions earlier than 7.22.4, you must enable the components that implement this feature.

For steps to enable these components in your updated version, see [Enabling and Disabling Probe Components](#). Use these steps to edit the platform's cr.yaml file, but *do not* apply those changes yet, via `kubectl`.

When you update the components in your cr.yaml file, specify the following:

```
kubeturbo:
  enabled: true
prometheus-mysql-exporter:
  enabled: true
mysql:
  user: root
  pass: vmturbo
prometheus:
  enabled: true
prometurbo:
  enabled: true
```

14. Verify that the Turbonomic application installed correctly.

To verify the installation of the application, execute the command:

```
kubectl get pods -n turbonomic
```

After all of the pods start up, the READY column should read 1/1 and the STATUS column should read Running for each pod.

15. Notify other users to clear their browser data and refresh their Turbonomic browser sessions.

Appendix: Migrating Turbonomic From Classic to XL

Note:

Deprecation Notice for Tbmigrate, the Classic-To-XL Migration Tool

Starting with the 8.5.0 release of Turbonomic, we will no longer support the Classic-To-XL Migration Tool. This tool provides a scripted interface that you can use to migrate from Classic installations (the 6.x version families) to XL installations (the 8.x version families).

You can still use this tool to migrate from Classic to the 8.4.x version family. We recommend that you migrate to version 8.4.0, then update to the latest version.

If you need to perform a migration after we release Turbonomic 8.5.0, you will be instructed to install and migrate to version 8.4.0, and then update that installation to the later version.

IBM is proud to introduce the XL family of the Turbonomic platform. XL comprises the 7.x and 8.x versions of Turbonomic. Also note that the 6.4.x versions of Turbonomic are referred to as *Classic*.

The XL family of Turbonomic is a new platform to manage application performance to the same standards you are used to with the Classic version family. It introduces a component-based architecture that can manage larger environments, as well as enhancements to the supply chain and user interface that emphasize the management and performance of your applications.

Because of these changes, you must *migrate* to the XL version family – You cannot perform a simple update like you would to update to a later version of the same family. A migration transfers your target, group, policy, and other data from your Classic installation, into the XL installation.

IBM provides a tool to perform the migration automatically. You set the IP addresses of your Classic installation and of your XL installation in the tool. It then discovers the data that it can migrate, and loads that data into the XL installation. The tool currently migrates:

- Target configurations
- Policies and schedules
- Templates
- Custom groups
- Discovered groups used to scope policies and targets
- Users and user groups, including Local and Active Directory user accounts

Note:

As of this writing, we have not tested migration of all target types. This is because of limited access to some target types in our testing lab.

Limitations

Please be aware of the following limitations to the migration tool:

- *Always migrate to a Quarterly Release of XL*

We deliver quarterly releases and bi-weekly releases of Turbonomic. We test the migration script against each quarterly release.

When you migrate from Classic to XL, you should always migrate to the latest *quarterly* release of XL. If you want to use a later bi-weekly release, migrate to the quarterly release first, and then update to the later bi-weekly release after you have completed the migration.

- You should not migrate multiple instances of Classic installations to a single XL installation. You should only migrate a single Classic instance to a single XL instance. If you want to migrate multiple instances of Classic, please contact your support representative.
- For AWS targets, the XL instance uses a separate target to manage billing. The tool does migrate the Classic AWS targets, but it does not create the separate billing target in the XL instance. For AWS environments, after you migrate to XL, you should manually configure the appropriate AWS Billing target.
- The tool does not migrate the following:
 - Your current license
 - Historical data
 - Dashboards and charts
 - Plans
 - Placements and reservations
 - Billing and cost configuration
 - Action scripts and orchestration configurations
 - Email and trap notification configuration
 - Reports and report templates
 - Data retention configuration
 - Email server configuration
 - HTTP Proxy configuration
 - SSO configurations
 - Logging levels

- Support options

Preparing your Turbonomic Instances

Before you can migrate, you must prepare the Classic and the XL instances for the migration. They must be updated to the correct versions, and you must have access to them via a secure shell session (SSH).

- Update your Classic instance to 6.4.22 or later

The tool requires that your Classic instance is no earlier than 6.4.22.

- Install the latest quarterly release of Turbonomic

This will be your XL instance. Install this instance on your network at the location you desire. The version you migrate to must be 8.1.6 or later.

Note:

When you install the XL instance, consider the following:

- *Always migrate to a Quarterly Release of XL*

We deliver quarterly releases and bi-weekly releases of Turbonomic. We test the migration script against each quarterly release.

When you migrate from Classic to XL, you should always migrate to the latest *quarterly* release of XL. If you want to use a later bi-weekly release, migrate to the quarterly release first, and then update to the later bi-weekly release after you have completed the migration.

- It is best to migrate to a newly installed XL instance. You must be careful if you use the tool to migrate your Classic instance onto a XL instance that already has targets, discovered entities and groups, or policies.
 - If you want to migrate to a previously installed version of Turbonomic, you must update that version to the latest quarterly release.
 - If you need to migrate multiple Classic instances to a single XL instance, please contact your support representative.
 - Gather addresses and credentials to access both instances of Turbonomic
- Ensure that you know:
- The IP address used to access both SSH (putty) and the UI of the Classic instance
 - SSH login credentials for the Classic instance
 - The IP address used to access the UI of the XL instance
 - UI administrator credentials for both the Classic and XL instances
 - Ensure that you have credentials for an Administrator user account through the user interfaces of the Classic and the XL instances of Turbonomic
- Ensure that you have a valid license on the XL instance.

If you do not have a valid license on the XL version, then the migration tool cannot execute.

- Double-check your access to the Turbonomic instances

Ensure that you can:

- Log into a secure shell session (SSH) on the Classic instance
- Access the REST API of the XL instance from the classic instance

To test this access, log into SSH on the Classic instance and execute the command:

```
curl -k https://XL_INSTANCE_IP/vmturbo/rest/cluster/isXLEnabled && echo
```

If you can connect with the XL REST API, the command output should be true.

- Log in to the UI of both the Classic and XL instances of Turbonomic via the administrator account.
- If you have deployed Kubeturbo in your Classic environment, deploy Kubeturbo for XL.

The tool does not migrate Kubeturbo deployments. This stage in the migration process is the perfect time to deploy Kubeturbo to operate with your XL installation. For more information, see the Kubeturbo github repository, located at <https://github.com/turbonomic/kubeturbo>.

If you declared (on your Classic instance) groups or policies that rely on the topology that Kubeturbo discovers, then you should manually create them in the XL instance. Note that the XL instance creates different entity types for your container infrastructure. Your associated groups and policies will use this new topology model.

- Ensure that all the targets in your environment are in a *Valid* state.

The migration tool will configure targets on the XL instance, to match the targets you have configured on your Classic instance. Before running the migration, you should ensure that all the targets validate. Either correct the issue, or delete the target.

If the migration encounters targets that do not validate, then it will post a failure error, and it will not migrate that target.

If you delete a target before migrating, or if the target migration fails, then the migration will not contain any groups that Turbonomic discovers to support that target. As a result, if you have any policies that rely on these discovered groups for scope, that scope will no longer exist. You should understand how policies use the given target's scope, and clean up or delete any policies that will have an empty scope because the target was removed.

- Impose an effective *freeze* on the configurations of your Classic and XL instances.

Once you start the migration process, you should not make any configuration changes to either the XL instance or the Classic instance.

There are two exceptions to this rule:

- Under some circumstances the tool can encounter a situation that requires you to abort a given step and make some changes. When the tool instructs you to make configuration changes, you can do so.

For example, if you want to migrate a target type that is not currently enabled in the XL instance, the tool will tell you to abort, enable the target on the XL instance, and resume the migration.

- Similarly, if your deployed Kubeturbo in your Classic instance, you will need to manually deploy Kubeturbo in the XL instance. The instructions include a step in the process where you can do that.

Installing the Migration Tool

To run the migration, install the tool on your Classic instance of Turbonomic.

1. Download the tool.

For access and download instructions, navigate to <https://github.com/turbonomic/tbmigrate/blob/master/DOWNLOAD.md>. Scroll to the section, *Downloading TbMigrate*.

Note:

Be sure to download the latest version of the migration tool.

2. Log in to the Classic instance using "putty" or another SSH client (if you have not done so already).
3. Expand the archive file onto your Turbonomic instance.

Execute the commands:

- `cd $HOME`
- `tar xvfz /tmp/tbmigrate-VERSION_NUMBER.tgz --no-same-owner`

Running the Migration

To run a migration you will open the Migration Tool Interactive Menu, and then execute the commands in order.

Note:

When using the Classic to XL migration tool, you must run the steps in order. If you run steps *after* the Migrate Targets step, and then backtrack to run the Migrate Targets step again, the tool loses the record of any steps that you ran after the initial execution of Migrate Targets.

We recommend that you carefully review the results of each step that you complete, before moving on to the next one. This can make it unnecessary for you to backtrack.

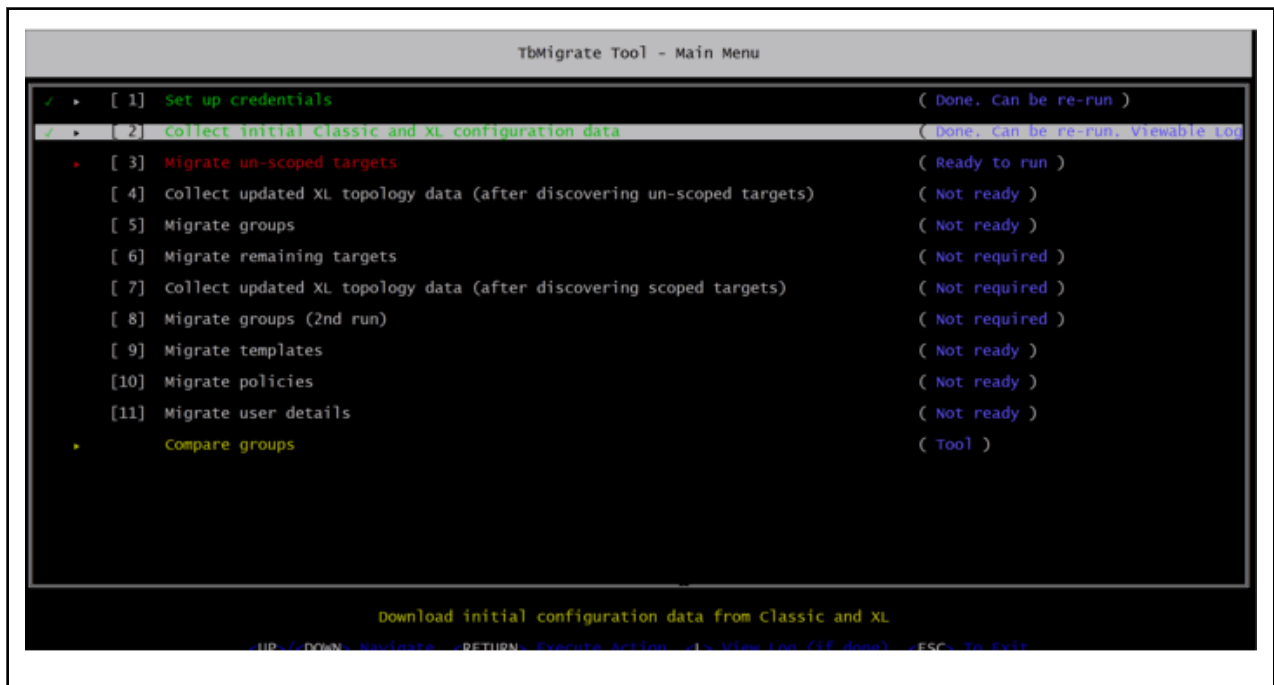
For example, assume you ran the tool all the way through the migration. Then you want to see how the tool calculated the target migration so you run Migrate Targets again. After that, the tool assumes you have not finished the migration, and will not let you review the steps subsequent to Migrate Targets. If you had closely reviewed the Migrate Targets result right after you executed that step, then you would not have needed to go back and run it again.

Open the Migration Tool Interactive Menu

While still logged in to the Classic instance, navigate to the migration tool location, and launch the Interactive Menu. Execute the commands:

- `cd $HOME/tbmigrate`
- `sh menu.sh`

The Interactive Menu displays in your shell window.



The menu gives you the migration steps you should perform, in order. In the menu:

- Each step has a status:
 - Ready to run – You should run steps in order.
 - Not ready – You must run previous steps before running this step.
 - Done – You can rerun some completed steps. For some completed steps, you can navigate to the step and then display logs.
 - Not required – Optional steps to migrate or collect data a second time.
- Use up and down arrows to navigate to different steps.
- For a selected step, you can:
 - Execute the menu command – Press RETURN to execute the selected step.

- Display associated logs – Press the "L" key to view logs for completed steps.
- Exit the step – Press ESC to exit the step

Executing the Migration Commands

Note:

As you execute the migration commands, they write output to .log files in the \$HOME/tbmigrate/logs directory.

You should review these logs carefully to ensure that you don't see negative impacts from any elements the tool could not migrate completely. You should review the logs when the migration is finished, and you can review them at different stages of the migration process.

To run the migration, you will step through the menu commands in order, and execute them. The following steps describe each menu command.

1. Set up credentials.

This step configures credentials for both instances. Execute the command, and then provide the information that the tool requests.

As part of the credential setup, this step prompts you with the **Target Password Migration** option:

- **YES** – The migration tool collects your encrypted target passwords, and uses them to configure and validate the targets that you migrate to the XL instance. You will not have to enter those passwords yourself during various stages of the target migration phase.
- **NO** – The migration tool does *not* collect your encrypted passwords. If you do not migrate passwords, you will see prompts to enter passwords at various stages during the target migration process.

2. Collect initial Classic and XL configuration data.

Collect the current configuration from your Classic installation.

This step collects configuration data from your instances. The migration process will use the collected data.

When this step completes, it generates a log of the actions it performed. You should review the log to be sure there are no errors.

3. Migrate un-scoped targets.

This step migrates all the targets that are not scoped to groups.

You should know that scoped targets can only migrate *after* Turbonomic has created the groups that define the scope. Turbonomic cannot create those groups until after the un-scoped targets have been configured, validated, and have discovered their entities. You will migrate scoped targets in a later step.

When you execute this step, the tool displays an interactive list of targets. (There can be a brief delay.) This list shows which targets *can* migrate (with a tick on the left), and which targets *cannot* migrate (marked with an X). Use this list to migrate your targets:

Note:

If you are migrating targets to an XL instance that *already has targets installed*, you must be sure that you do not create duplicate targets. This can happen if one of the XL targets is the same as a target in the interactive list.

The list will identify duplicates and disable their migration if the target names are identical, including case. However, it cannot identify duplicates if the names are spelled differently in any way.

If you are migrating to a XL instance that already has targets running on it, review this list carefully to make sure there is no duplicate target in the list.

- Navigate in the list

Use the UP and DOWN arrow keys to move from target to target and view the message shown at the bottom of the screen for each one.

Take a note of any targets that need to have their supporting mediation pod enabled on the XL instance. You will need to enable those probes on the XL instance later, and then perform the target migration step again.

For any target you do not want to migrate, navigate to that entry and press the space bar to deselect it.

- Exit the list of targets.

When you have finished viewing and selecting the targets to migrate, press the ESC key to exit the list.

The tool gives you a Yes/No option to continue with the migration. You must decide whether to continue or abort the target migration.

- If you need to install missing probes on the XL instance, install them now.

Choose No to abort the migration. Then start a session on the XL instance to install the missing probes that you noted. For instructions, see the Installation Guide.

After you install the missing probes on the XL instance, return to the Classic instance and execute the **Migrate Unscoped Targets** command again.

- If you do not need to install any missing probes on the XL instance, proceed with the migration.

Choose Yes. The tool will migrate the targets that you have selected in the list.

- Confirm that the target migration does not report any errors.
- Take a note of the whether the tool output ends with the message, There are some scoped targets to be migrated later.

Wait for the migrated targets to validate and discover their topology.

You can monitor the discovery in the XL instance by logging into its user interface. Alternatively, you can use the following commands from the SSH on the Classic instance to see reports of the supply chain and the target status on the XL instance:

- `bin/tbutil @xl list supplychain` to see the supply chain
- `bin/tbutil @xl list targets -l` to list target status

You can use the "watch" tool to re-run either of these tools repeatedly. For example:

```
watch -n 10 bin/tbutil @xl list supplychain
```

When finished with the "watch" session, press Control-C to stop the command.

Some tips for waiting for the migration to complete:

- The message `W00PS! Supplychain object not found` indicates that no entities have been discovered. Assuming one or more targets have validated, this means that discovery has not yet generated any topology.
- Be aware that the numbers shown may increase over time as more targets complete their discovery. You should wait until all discovery is complete.
- The numbers in the "Minor", "Major" and "Critical" columns should all be zero. This is because actions are disabled globally for the XL instance, and so there are no actions in the system. You will enable actions for the XL instance when you cut your management over to that new instance.
- If you see target validation issues on the XL instance, you can log into the XL user interface and change the credentials or other settings for the target configuration. Then you can trigger re-validation and re-discovery for the affected targets.

Once all the targets are validated and discovery is complete, you can continue to the next step.

4. Collect updated XL topology data.

The topology of the XL instance has changed since you did the original "Collect" step (Step 2). You must repeat the "Collect" step now. Execute the step, and when it completes review the log to make sure there are no errors.

5. Migrate groups.

This step migrates your custom groups. It also migrates *scope* groups that can be created from the un-scoped targets. This enables the eventual migration of scoped targets.

Note that this step does not migrate most discovered groups. The XL instance will discover groups according to its own rules.

Execute the step, and when it completes review the log to make sure there are no errors.

6. Migrate remaining targets.

If the earlier "Migrate un-scoped targets" step displayed the message *There are some scoped targets to be migrated later*, then you must migrate them now. If that step reported the message, *There are no outstanding scoped targets*, then you can skip the next few steps, and jump to "Migrate templates".

Executing this step is the same as the "Migrate un-scoped targets" step, except that it now migrates the scoped targets. It displays the same interactive list of targets to migrate. It also identifies any probes that you need to install on the XL instance. For full details, please refer to the "Migrate un-scoped targets" step, above.

Note:

If you are migrating targets to an XL instance that *already has targets installed*, you must be sure that you do not create duplicate targets. This can happen if one of the XL targets is the same as a target in the interactive list.

The list will identify duplicates and disable their migration if the target names are identical, including case. However, it cannot identify duplicates if the names are spelled differently in any way.

If you are migrating to a XL instance that already has targets running on it, review this list carefully to make sure there is no duplicate target in the list.

Briefly, to migrate any scoped targets, execute the step, and then:

- Answer any questions that the tool asks you. Use the UP and DOWN arrow keys to navigate the list. Press the space bar to select or deselect a target in the list.
- Take a note of any targets that need to have their supporting mediation pod enabled on the XL instance. You will need to exit this migration step, enable those probes on the XL instance, and then perform this target migration step again.

To abort this migration step, press ESC, and then choose No.

- If you do not need to install any missing probes on the XL instance, proceed with the migration. Press ESC and then choose Yes. The tool will migrate the targets that you have selected in the list.
- Confirm that the target migration does not report any errors.

Wait for the migrated targets to validate and discover their topology.

You can monitor the discovery in the XL instance by logging into its user interface. Alternatively, you can use the following commands from the SSH on the Classic instance to see reports of the supply chain and the target status on the XL instance:

- `bin/tbutil @xl list supplychain` to see the supply chain
- `bin/tbutil @xl list targets -l` to list target status

7. Collect the updated XL topology data.

The topology of the XL instance has changed again. You must repeat the "Collect" step now. Execute the step, and when it completes review the log to make sure there are no errors.

8. Migrate groups.

Migrate additional groups that are related to the scoped targets.

This step updates the groups to use the new topology that has been discovered by the scoped targets. Execute the step, and when it completes review the log to make sure there are no errors.

9. Migrate templates.

This step migrates the templates you have defined in the Classic instance. It does not migrate generated templates such as average cluster templates, nor does it migrate discovered templates. Execute the step, and when it completes review the log to make sure there are no errors.

10. Migrate policies.

This step migrates your Placement Policies, and your default and custom Automation Policies.

For Automation Policies, this step copies automation settings from classic to XL that meet all of the following criteria:

- The setting had been changed in the Classic instance.

In other words, the setting has a value that is different from its default.

- There is an equivalent setting in the XL instance.

Note that not all settings in Classic have been replicated in XL. On the other hand, XL introduces new settings that do not exist in Classic.

This step also migrates Placement Policies.

If the migration encounters settings in Classic that cannot migrate into XL (or vice versa), the tool writes a suitable warning to the log. Examples include:

- Action policies for entity types that do not map to the XL supply chain. For example, *Application* in Classic entities are *Application Component* entities in XL.
- Settings do not match. For example, in Classic you can set SLA Capacity for a Business Application, XL does not include that setting.
- Settings that are specified by a different mechanism. For example, settings for Action Scripts are specified differently in XL.

Execute the step, and when it completes review the log to make sure there are no errors.

11. Migrate user details.

This step migrates:

- Local Users – The migration includes all the user details (Role, scope, etc.) *except* the user's password. The migration creates an arbitrary and complex password for each user in the XL installation. The Turbonomic administrator can edit each local user account, and work with the individual user to manually update the password.
- LDAP Users – The migration includes all the user's details.
- LDAP User Group – The migration includes all the group details
- Active Directory Configuration – The migration includes the AD settings that you had specified in the Classic installation

This completes the migration process.

You should review the tool outputs to ensure there are no errors. If the tool did log errors, you can review them to determine corrective actions you can take in the XL instance. The tool writes output to `.log` files in the `$HOME/tbmigrate/logs` directory.

Once all the above steps are complete, the XL instance is configured to be as similar as possible to the Classic instance, but you should verify that the configuration is as you expect. In particular, review the warnings and errors that the tool logged for any of the migration steps above. You should consider whether these warnings or errors can have an impact on your environment. If necessary, you can log into the XL user interface and make corrections there.

Switching to the New Version

After you have completed the migration, you should plan your change over from the Classic version of Turbonomic to the XL version.

Letting the Migration "Settle In"

After running the migration process, the XL instance discovers your environment, creates groups, and begins its market analysis. However, actions are disabled globally for the XL instance. This is important – You must not have two instances that actively manage the same environment at the same time. By disabling actions in the XL instance, the migration process ensures that it does not execute actions until you are ready for it to.

It is a good practice to leave the XL instance running with actions disabled for a period of time. You should let it run in parallel with the Classic instance, and keep actions enabled on the Classic instance. In this way, you let the XL instance catch up, while the Classic instance continues to manage your environment:

- **XL Instance (actions disabled):** This instance builds up historical data that Turbonomic analysis uses to generate resizing actions.
- **Classic Instance (actions enabled):** This instance continues to manage your environment while the XL instance "settles in".

You can use this time to check that your XL instance is discovering utilization and capacity metrics correctly, and to set up policies and other business rules. This is also a good time to address any configuration settings that the tool did not migrate. For example, you can go over the **Limitations** section above to address the items the tool did not migrate.

Note:

As a rule, you should allow the migration to settle in for 30 to 90 days. This should be sufficient for the XL instance to collect the historical data it needs to properly work with cloud costs and percentile-based analysis.

Cutting Management Over to the XL Instance

When you are sure that the XL instance has collected sufficient historical data, and that the configuration of the XL instance is correct, then you can switch the management of your environment over from Classic to XL.

There are two steps to this process, and the order is important:

1. Turn on **Disable All Actions** in the Classic instance and wait for all actions to clear.

Navigate to **Settings > Policies**. Then in the Search box for the Policies list, type *global* to find the **Global Defaults** policy. Click to edit that policy. Under ACTION CONSTRAINTS, turn on the **Disable All Actions** option. Then click **SAVE AND APPLY**.

After you have disabled actions, wait for the Pending Actions list to clear so that it shows no actions.

2. Turn *off* **Disable All Actions** in the XL instance.

navigate to the **Global Defaults** policy and turn off the **Disable All Actions** option. The XL instance should begin generating actions, and you can use it to manage your environment.

Chapter 4. Product Overview

Thank you for choosing Turbonomic, the premier solution for Application Resource Management (ARM) of cloud and virtual environments.

Application Resource Management is a top-down, application-driven approach that continuously analyzes applications' resource needs and generates fully automatable actions to ensure applications always get what they need to perform. It runs 24/7/365 and scales with the largest, most complex environments.

To perform Application Resource Management, Turbonomic represents your environment holistically as a *supply chain* of resource *buyers* and *sellers*, all working together to meet application demand. By empowering buyers (VMs, instances, containers, and services) with a budget to seek the resources that applications need to perform, and sellers to price their available resources (CPU, memory, storage, network) based on utilization in real-time, Turbonomic keeps your environment within the *desired state* — operating conditions that achieve the following conflicting goals at the same time:

- Assured application performance

Prevent bottlenecks, upsize containers/VMs, prioritize workload, and reduce storage latency.

- Efficient use of resources

Consolidate workloads to reduce infrastructure usage to the minimum, downsize containers, prevent sprawl, and use the most economical cloud offerings.

Turbonomic is a containerized, microservices architected application running in a Kubernetes environment (or within a VM) on your network or a public cloud VPC. You then assign services running on your network to be Turbonomic *targets*. Turbonomic discovers the entities (physical devices, virtual components and software components) that each target manages, and then performs analysis, anticipates risks to performance or efficiency, and recommends actions you can take to avoid problems before they occur.

How Turbonomic Works

To keep your infrastructure in the desired state, Turbonomic performs Application Resource Management. This is an ongoing process that solves the problem of assuring application performance while simultaneously achieving the most efficient use of resources and respecting environment constraints to comply to business rules.

This is not a simple problem to solve. Application Resource Management has to consider many different resources and how they are used in relation to each other, and numerous control points for each resource. As you grow your infrastructure, the factors for each decision increase exponentially. On top of that, the environment is constantly changing — to stay in the desired state, you are constantly trying to hit a moving target.

To perform Application Resource Management, Turbonomic models the environment as a *market* made up of *buyers* and *sellers*. These buyers and sellers make up a *supply chain* that represents tiers of entities in your inventory. This supply chain represents the flow of resources from the datacenter, through the physical tiers of your environment, into the virtual tier and out to the cloud. By managing relationships between these buyers and sellers, Turbonomic provides closed-loop management of resources, from the datacenter, through to the application.

See [Supply Chain of Entities](#) for a visual layout of the buyer and seller relationships.

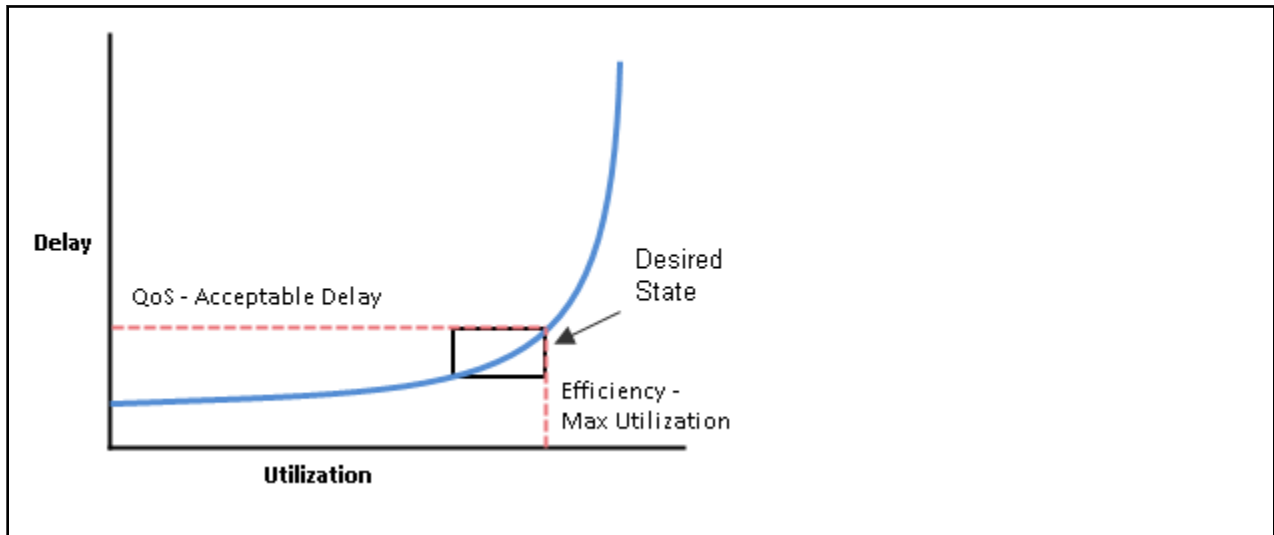
Turbonomic uses *Virtual Currency* to give a budget to buyers and assign cost to resources. This virtual currency assigns value across all tiers of your environment, making it possible to compare the cost of application transactions with the cost of space on a disk or physical space in a data center.

The price that a seller charges for a resource changes according to the seller's supply. As demand increases, prices increase. As prices change, buyers and sellers react. Buyers are free to look for other sellers that offer a better price, and sellers can duplicate themselves (open new storefronts) to meet

increasing demand. Turbonomic uses its *Economic Scheduling Engine* to analyze the market and make these decisions. The effect is an invisible hand that dynamically guides your IT infrastructure to the optimal use of resources.

To get the most out of Turbonomic, you should understand how it models your environment, the kind of analysis it performs, and the desired state it works to achieve.

The Desired State



The goal of Application Resource Management is to assure performance while maintaining efficient use of resources. When performance and efficiency are both maintained, the environment is in the desired state. You can measure performance as a function of delay, where zero delay gives the ideal QoS for a given service. Efficient use of resources is a function of utilization where 100% utilization of a resource is the ideal for the most efficient utilization.

If you plot delay and utilization, the result is a curve that shows a correlation between utilization and delay. Up to a point, as you increase utilization, the increase in delay is slight. There comes a point on the curve where a slight increase in utilization results in an unacceptable increase in delay. On the other hand, there is a point in the curve where a reduction in utilization doesn't yield a meaningful increase in QoS. The desired state lies within these points on the curve.

You could set a threshold to post an alert whenever the upper limit is crossed. In that case, you would never react to a problem until delay has already become unacceptable. To avoid that late reaction you could set the threshold to post an alert before the upper limit is crossed. In that case, you guarantee QoS at the cost of over-provisioning — you increase operating costs and never achieve efficient utilization.

Instead of responding *after* a threshold is crossed, Turbonomic analyzes the operating conditions and constantly recommends actions to keep the entire environment within the desired state. If you execute these actions (or let Turbonomic execute them for you), the environment will maintain operating conditions that assure performance for your customers, while ensuring the lowest possible cost thanks to efficient utilization of your resources.

The Market and Virtual Currency

To perform Application Resource Management, Turbonomic models the environment as a market, and uses market analysis to manage resource supply and demand. For example, bottlenecks form when local workload demand exceeds the local capacity — in other words, when demand exceeds supply. By modeling the environment as a market, Turbonomic can use economic solutions to efficiently redistribute the demand or increase the supply.

Turbonomic uses two sets of abstraction to model the environment:

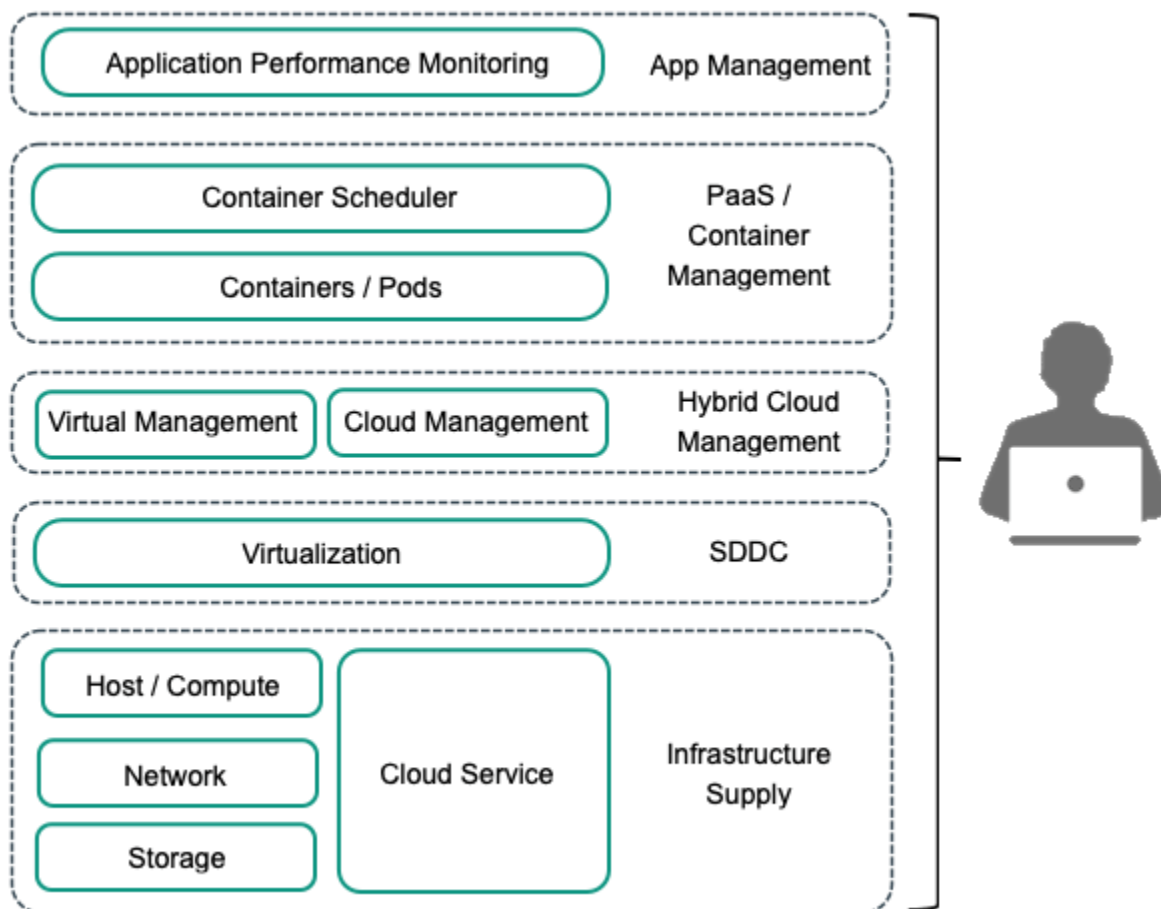
- Modeling the physical and virtual IT stack as a service supply chain

The supply chain models your environment as a set of managed entities. These include applications, VMs, hosts, storage, containers, availability zones (cloud), and data centers. Every entity is a buyer, a seller, or both. A host machine buys physical space, power, and cooling from a data center. The host sells resources such as CPU cycles and memory to VMs. In turn, VMs buy host services, and then sell their resources (VMem and VCPU) to containers, which then sell resources to applications.

See [Supply Chain of Entities](#) for a visual layout of the buyer and seller relationships.

- Using virtual currency to represent delay or QoS degradation, and to manage the supply and demand of services along the modeled supply chain

The system uses virtual currency to value these buy/sell transactions. Each managed entity has a running budget — the entity adds to its budget by providing resources to consumers, and the entity draws from its budget to pay for the resources it consumes. The price of a resource is driven by its utilization — the more demand for a resource, the higher its price.



These abstractions open the whole spectrum of the environment to a single mode of analysis — market analysis. Resources and services can be priced to reflect changes in supply and demand, and pricing can drive resource allocation decisions. For example, a bottleneck (excess demand over supply) results in rising prices for the given resource. Applications competing for the same resource can lower their costs by shifting their workloads to other resource suppliers. As a result, utilization for that resource evens out across the environment and the bottleneck is resolved.

Risk Index

Turbonomic tracks prices for resources in terms of the *Risk Index*. The higher this index for a resource, the more heavily the resource is utilized, the greater the delay for consumers of that resource, and the greater the risk to your QoS. Turbonomic constantly works to keep the Risk Index within acceptable bounds.

You can think of Risk Index as the cost for a resource — Turbonomic works to keep the cost at a competitive level. This is not simply a matter of responding to threshold conditions. Turbonomic analyzes the full range of buyer/seller relationships, and each buyer constantly seeks out the most economical transaction that is available.

This last point is crucial to understanding Turbonomic. The virtual environment is dynamic, with constant changes to workload that correspond with the varying requests your customers make of your applications and services. By examining each buyer/seller relationship, Turbonomic arrives at the optimal workload distribution for the current state of the environment. In this way, it constantly drives your environment toward the desired state.

Note:

The default Turbonomic configuration is ready to use in many environments. However, you can fine-tune the configuration to address special services and resources in your environment. Turbonomic provides a full range of policies that you can set to control how the software manages specific groups of entities. Before you make such policy changes, you should understand default Turbonomic operation. For more information about policies, see [Working With Policies](#).

The Turbonomic Supply Chain

Turbonomic models your environment as a market of buyers and sellers. It discovers different types of entities in your environment via the targets you have added, and then maps these entities to the supply chain to manage the workloads they support. For example, for a hypervisor target, Turbonomic discovers VMs, the hosts and datastores that provide resources to the VMs, and the applications that use VM resources. For a Kubernetes target, it discovers services, namespaces, containers, container pods, and nodes. The entities in your environment form a chain of supply and demand where some entities provide resources while others consume the supplied resources. Turbonomic *stitches* these entities together, for example, by connecting the discovered Kubernetes nodes with the discovered VMs in vCenter.

For information about specific members of the supply chain, see [Supply Chain of Entities](#).

Supply Chain Terminology

IBM introduces specific terms to express IT resources and utilization in terms of supply and demand. These terms are largely intuitive, but you should understand how they relate to the issues and activities that are common for IT management.

Term:	Definition:
Commodity	<p>The basic building block of Turbonomic supply and demand. All the resources that Turbonomic monitors are commodities. For example, the CPU capacity or memory that a host can provide are commodities. Turbonomic can also represent clusters and segments as commodities.</p> <p>When the user interface shows <i>commodities</i>, it's showing the resources a service provides. When the interface shows <i>commodities bought</i>, it's showing what that service consumes.</p>
Composed Of	<p>The resources or commodities that make up the given service. For example, in the user interface you might see that a certain VM is <i>composed of</i> commodities such as one or more physical CPUs, an Ethernet interface, and physical memory.</p> <p>Contrast <i>Composed Of</i> with <i>Consumes</i>, where consumption refers to the commodities the VM has bought. Also contrast <i>Composed Of</i> with the commodities a service offers for sale. A host might include four CPUs in its composition, but it offers CPU Cycles as a single commodity.</p>

Term:	Definition:
Consumes	The services and commodities a service has bought. A service <i>consumes</i> other commodities. For example, a VM consumes the commodities offered by a host, and an application consumes commodities from one or more VMs. In the user interface you can explore the services that provide the commodities the current service consumes.
Entity	A buyer or seller in the market. For example, a VM or a datastore is an entity.
Environment	The totality of data center, network, host, storage, VM, and application resources that you are monitoring.
Inventory	The list of all entities in your environment.
Risk Index	<p>A measure of the risk to Quality of Service (QoS) that a consumer will experience. The higher the Risk Index on a provider, the more risk to QoS for any consumer of that provider's services.</p> <p>For example, a host provides resources to one or more VMs. The higher the Risk Index on the provider, the more likely that the VMs will experience QoS degradation.</p> <p>In most cases, for optimal operation the Risk Index on a provider should not go into double digits.</p>

Turbonomic Targets

You can assign instances of the following technologies as Turbonomic targets:

- Applications and Databases
 - Apache Tomcat 7.x, 8.x, and 8.5.x
 - AppDynamics 4.1+
 - AppInsights
 - Dynatrace 1.1+
 - IBM WebSphere Application Server 8.5+
 - Instana, release-209 or later
 - JBoss Application Server 6.3+
 - JVM 6.0+
 - Microsoft SQL Server 2012, 2014, 2016, 2017, and 2019
 - MySQL 5.6.x and 5.7.x
 - NewRelic
 - Oracle 11g R2, 12c, 18c, and 19c
 - Oracle WebLogic 12c
- Cloud Native
 - Kubernetes, including any compliant k8s distribution (Rancher, Tanzu, open source, etc.)
 - Cloud-hosted k8s services (AKS, EKS, GKE, IBM, Cisco IKS, ROKS, ROSA, etc.)
 - OpenShift 3.11 and higher (OCP 4.x)
- Fabric and Network
 - Cisco UCS Manager 3.1+

- HPE OneView 3.00.04
- Guest OS Processes
 - SNMP
 - WMI: Windows versions 8 / 8.1, 10, 2008 R2, 2012 / 2012 R2, 2016, 2019 and 7
- Hyperconverged
 - Cisco HyperFlex 3.5
 - Nutanix Community Edition
 - VMware vSAN
- Hypervisors
 - Microsoft Hyper-V 2008 R2, Hyper-V 2012/2012 R2, Hyper-V 2016, Hyper-V 2019
 - VMware vCenter 6.0, 6.5, 6.7, and 7.0+
- Orchestrator
 - Action Script
 - Flexera One
 - ServiceNow
- Private Cloud
 - Microsoft System Center 2012/2012 R2 Virtual Machine Manager and System Center 2016 Virtual Machine Manager
- Public Cloud
 - Amazon AWS
 - Amazon AWS Billing
 - Google Cloud Platform (GCP)
 - Google Cloud Platform (GCP) Billing
 - Microsoft Azure Service Principal
 - Microsoft Enterprise Agreement
- Storage
 - EMC ScaleIO 2.x and 3.x
 - EMC VMAX using SMI-S 8.1+
 - EMC VPLEX Local Architecture with 1:1 mapping of virtual volumes and LUNs
 - EMC XtremIO XMS 4.0+
 - HPE 3PAR InForm OS 3.2.2+, 3PAR SMI-S, 3PAR WSAPI
 - IBM FlashSystem running on Spectrum Virtualize 8.3.1.2 or later (8.4.2.0 or later recommended)
 - NetApp Cluster Mode using ONTAP 8.0+ (excluding AFF and SolidFire)
 - Pure Storage F-series and M-series arrays
- Virtual Desktop Infrastructure
 - VMware Horizon

The following sections describe these targets. For information about assigning targets to Turbonomic, see the Target Configuration Guide.

Hypervisors

Turbonomic can use a range of VM managers as targets. For general discussion, this document refers to the various supported VM managers as hypervisors.

Turbonomic uses hypervisor targets to access information about the managed VMs, hosts, and datastores, and also to execute commands such as provisioning, resizing, or reconfiguring entities in the environment. Through the hypervisor, Turbonomic can perform system monitoring, report on wasted storage, recommend actions, execute moves for VMs and VM storage, and execute VM reconfiguration (change CPU count, memory, etc.).

The entities Turbonomic discovers through hypervisor targets include:

- VMs
- Physical machines that host VMs
- Datastores that support the VMs
- Datacenters

Cloud Managers

Cloud Managers provide a layer of control to deliver virtual infrastructures that can be deployed automatically, or in a self-service offering to customers. They define and manage virtual datacenters (VDCs) — provider VDCs to manage the physical and virtual resources that support the cloud offering, and consumer VDCs that present limited resources to customers.

You can create special Turbonomic user accounts for consumer VDC customers. Such an account has a limited scope, and the user cannot see any of the resources outside of that scope. In this way, you can offer Turbonomic to cloud customers without exposing any proprietary infrastructure data to them. For more information, see [Managing User Accounts](#).

The entities Turbonomic discovers through cloud manager targets include:

- Consumer VDCs
Virtual resources that are available to customers.
- Provider VDCs
Physical resources that provide the infrastructure to support Consumer VDCs.

Storage Managers

Storage managers provide management and distribution of data storage across disk arrays. Storage managers can support thin provisioning, deduplication, and HA architectures. Turbonomic monitors resource utilization across the storage system to optimize placement and provisioning of volumes and disk arrays, as well as management of storage controller resources.

The entities Turbonomic discovers through storage manager targets include:

- Storage Controllers (NetApp controllers/filers, VNX processors)
- Disk Arrays (aggregates, clustered aggregates, storage pools, RAID groups)
- Datastores (volumes or LUNs)

Fabric Managers

Fabric managers provide a point of control for fabrics that unify compute, network, storage, and virtual resources within a single system.

The entities Turbonomic discovers through fabric managers targets include:

- UCS Domains
- Chassis
- Fabric Interconnects
- IO Modules

Resource Descriptions

To perform intelligent workload balancing, Turbonomic collects raw data from its target servers – hypervisors, cloud management stacks, public cloud accounts, etc. Turbonomic polls its targets at 10-minute intervals to collect the latest data samples. It then uses these 10-minute data points for analysis and to display data in the GUI.

The way Turbonomic collects host memory data from vCenter Server illustrates how this works. vCenter Server collects peak metrics from its managed VMs at 20-second intervals. Every ten minutes Turbonomic polls vCenter Server to collect its last round of data samples (30 samples in 10 minutes). To track a VM's utilization of host memory, Turbonomic requests *memory.active* data samples from vCenter. From that polling, Turbonomic can track:

- Peak Memory Utilization - Turbonomic uses the greatest value in each polling sample. This gives the highest percentage of active memory utilization for the selected VM (or group of VMs), calculated over the selected time period. For a maximum value, Turbonomic uses the highest observed active memory value in the data sample.
- Average Memory Utilization - Turbonomic averages all the values in each polling sample.

The following table lists the metrics Turbonomic collects, and includes details about how they are collected or measured. When the Turbonomic user interface plots charts of clusters or groups of devices, these charts show the average of the percentage of allocated resources that are used.

Resource:	Description:
1- 2- 4-CPU Rdy	Wait time in the ready queue on the host, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues on hosts. Charts show 1 - 4 CPU values. The charts show the percentage allocated ready queue capacity that is in use on the host. For host charts, this is a measure of the total ready queue wait time for all the VMs running on that host.
Balloon	Ballooning capacity on the PM, measured in KBytes. This capacity is the greater of: <ul style="list-style-type: none">• 65% of the VMem configured for all powered-on VMs that the PM hosts• The physical memory capacity of the PM Charts show the percentage of the PM's ballooning capacity that is in use.
Buffer	For network environments that support buffered switch ports (Arista networks), this resource measures utilization of a port buffer. For example, if a host connects to the network through port 1 on a switch, and that port has enough traffic to cause packet buffering, this resource will show utilization.
Connection	The connections in use, as a percentage of the maximum connections allowed on the database. Database configuration determines the capacity for this resource.
Cooling	Allocated cooling indicates the highest acceptable running temperature for a physical device, such as a chassis in a compute fabric.
CPU	Host CPU capacity, measured in MHz. This shows what percentage of CPU cycles are devoted to processing instructions. <ul style="list-style-type: none">• Host charts show the percentage of the host's CPU capacity that is in use.• VM charts show the percentage of the host's CPU capacity that is consumed by the given VM.

Resource:	Description:
DBMem	The memory in use by the database, as a percentage of the allocated capacity. Database configuration determines the capacity for this resource. Note that for databases, Turbonomic uses this resource to drive actions, instead of the VMem on the hosting VM. This means that actions are driven by the actual memory consumption on the database.
Flow0 — InProvider Flow	For measuring network flow, the flow that is within a single provider — For example, the network flow between VMs that are hosted by the same physical machine. This measures network flow between consumers that are on the same set of closely connected providers. Charts show the percentage of capacity that is utilized. Note that Turbonomic assumes an unlimited supply of InProvider Flow because this flow does not go across the physical network.
Flow1 — InDPOD Flow	For measuring network flow, the flow that is local to the given DPOD. This measures network flow between consumers that are on the same set of closely connected providers. Charts show the percentage of capacity that is utilized.
Flow2 — CrossDPOD Flow	For measuring network flow, the flow that is between different DPODs. This measures network flow between consumers that are on different sets of closely connected providers. Charts show the percentage of capacity that is utilized.
Heap	The heap capacity allocated for an Application Component. Charts show the percentage of capacity that is used by an Application Component.
HotStorage	For Nutanix platforms, the storage capacity on the server-attached flash.
IO	Data rate through the host's IO adapter, measured in KBytes/sec. <ul style="list-style-type: none"> • Datacenter charts show the average percentage of the host IO capacity that is in use, for all the hosts in the datacenter. • Host charts show the percentage of the host's total IO capacity that is in use.
IOPS	Storage access operations per second. Charts show the percentage of allocated IOPS capacity that is used on a datastore.
Latency	Allocated capacity for latency on a datastore. This measures the latency experienced by all VMs and hosts that access the datastore. Charts show the percentage of allocated latency that is in use on the datastore.
Mem	Host memory, measured in Kbytes. <ul style="list-style-type: none"> • Host charts show the percentage of the host's memory that is in use. • VM charts show the percentage of the host's memory that is consumed by the given VM.
NET	Data rate through the host's Network adapter, measured in Kbytes/sec. <ul style="list-style-type: none"> • Datacenter charts show the average percentage of the host NET capacity that is used for all the hosts in the datacenter. • Host charts show the percentage of the host's total NET capacity that is in use.
nfu (AWS only)	Normalized Factor Unit.

Resource:	Description:
	<p>For RIs in AWS environments, the nfu is a measure of RI capacity that you can use to compare or combine the capacity for different template families. For example, the normalized factors for some template families include:</p> <ul style="list-style-type: none"> • nano: 0.25 • micro: 0.5 • small: 1 • medium: 2 • large: 4 <p>Turbonomic measures RI utilization and coverage in terms of these normalized factors.</p>
Power	A measure of the power that is consumed by a physical device.
RI ratio (Azure only)	<p>For Azure environments, RI ratio is the number of RI units compared to the total number of RI units for a given Turbonomic scope. Each workload is assigned RI units based on its instance type. For example, here are some instance types with RI units:</p> <ul style="list-style-type: none"> • Standard_DS2_v2: 1 • Standard_B2ms: 3 <p>RI ratio information appears in the tooltips of cloud RI charts. Information about the Azure instance types and their RI workloads is provided in the RI Inventory chart.</p> <p>Azure RI ratio and AWS NFU are equivalent concepts.</p>
Response Time	Response time in ms. You set response time capacity in the Policies view.
Swap	The rate of memory swapping to disk, in bytes per second. The default capacity is 5,000,000 Byte/sec.
Threads	Allocated thread capacity. Charts show the percentage of thread capacity that is consumed by an Application Component.
TransactionLog	The disk space devoted to transaction logging for a database.
Transactions	Transactions per second. Charts show the percentage of allocated transaction capacity that is in use.
Risk Index	<p>A measure of the impact on Quality of Service (QoS) that a consumer will experience. The higher the Risk Index on a provider, the more risk to QoS for any consumer of that provider's services.</p> <p>For all the resources that impact performance or risk, charts show the Risk Index for the most utilized resource of a given entity. For example, if a host has a Risk Index of 6 for MEM and 12 for CPU, the chart will show the higher value.</p>
VCPU	The allocated CPU capacity, measured in MHz. Charts show the percentage of VCPU cycles that are devoted to processing instructions.
VMem	The allocated memory capacity, measured in Kbytes. Charts show the percentage of VMem that is in use.

Resource:	Description:
	<p>Note that percentages of allocated VMem are measured against whichever is the less of: The VMem limit (if set) or the allocated VMem capacity. This is also true in reports and recommended actions. For example, assume a VM with allocated VMem of 8 GB, but a limit of 4 GB. In this case, the percentage in a chart shows the percentage utilized of 4GB.</p>
VStorage	<p>The allocated virtual storage capacity, measured in Kbytes. Charts show the percentage of storage that is in use.</p>

Chapter 5. Getting Started

To get started with the platform, open a web browser to your Turbonomic installation. The Turbonomic platform serves the user interface to your browser, where you can log in and get started managing your environment. In this way, you can access the unique capabilities of Turbonomic from any internet connection.

Logging In to Turbonomic

To get started with the platform, open a web browser to your Turbonomic installation. The Turbonomic platform serves the user interface to your browser, where you can log in and get started managing your environment. In this way, you can access the unique capabilities of Turbonomic from any internet connection.

Before you can log in, your enterprise must have a valid Turbonomic account, or an instance of Turbonomic must be installed in your environment. To get the IP address of your Turbonomic installation, contact your system administrator.

To log in to Turbonomic:

1. Navigate your Web browser to the Turbonomic installation.

For the URL, provide the IP address or machine name for the installation. This URL opens the Turbonomic Login page. You should bookmark this URL for future use.

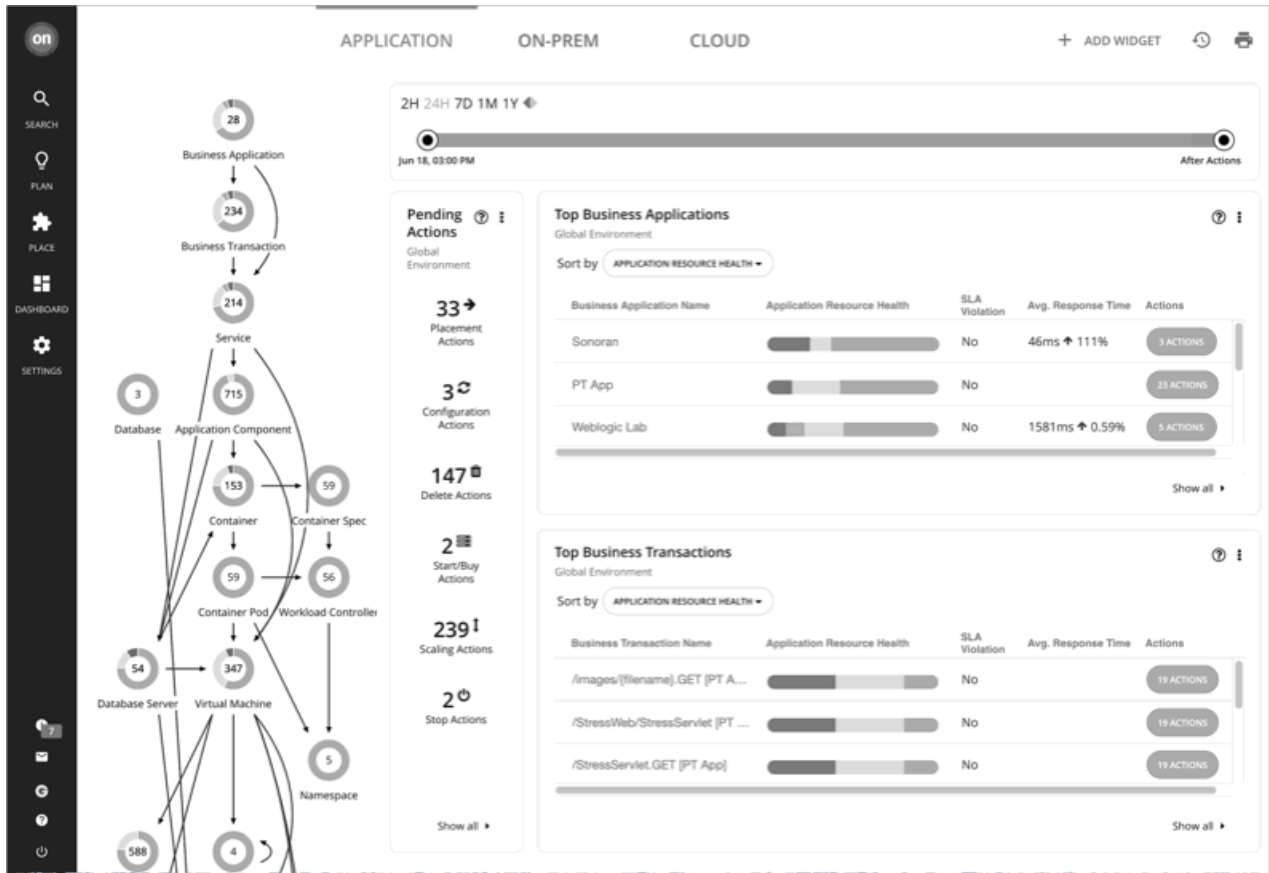
2. Provide the user name and password for your account.

Your system administrator creates user accounts. Contact your system administrator for login information.

After you log in, the browser opens to the [Home Page](#). This page is your starting point for sessions with the Turbonomic platform. From the Home Page you can see the overviews of your environment.

To display this information, Turbonomic communicates with *target services* such as hypervisors, storage controllers, and public cloud accounts. Note that your Turbonomic administrator sets up the target configuration. For information about supported targets and how to configure them, see [Target Configuration](#).

The Home Page



When you launch Turbonomic, the **Home Page** is the first view you see. From there you can:

- Choose a View to see overviews of your environment:
 - APPLICATION – See your environment in the context of your [Business Applications](#).
 - ON-PREM – See details for the on-prem environment. Notice that the Supply Chain excludes cloud entities and only shows the entities that are on-prem.
 - CLOUD – See details for the cloud environment, including pending actions, a listing of your cloud accounts by cost, the locations of cloud datacenters that you are using, estimated costs, and other cost-related information.
- Use the Supply Chain Navigator to inspect lists of entities

Click an entity tier in the Supply Chain to see a list of those entities. For example, click Virtual Machine to see a list of all the VMs in your environment.
- Navigate to other Turbonomic pages, including:
 - Search – Set the session scope to drill down to details about your environment
 - Plan – Run what-if scenarios
 - Place – Use Turbonomic to calculate the best placement for workloads, and execute the placement at the time you specify
 - Dashboards – Set up custom views with charts that focus on specifics in your environment
 - Settings – Configure Turbonomic to set up business rules and policies, configure targets, define groups, and perform other administrative tasks

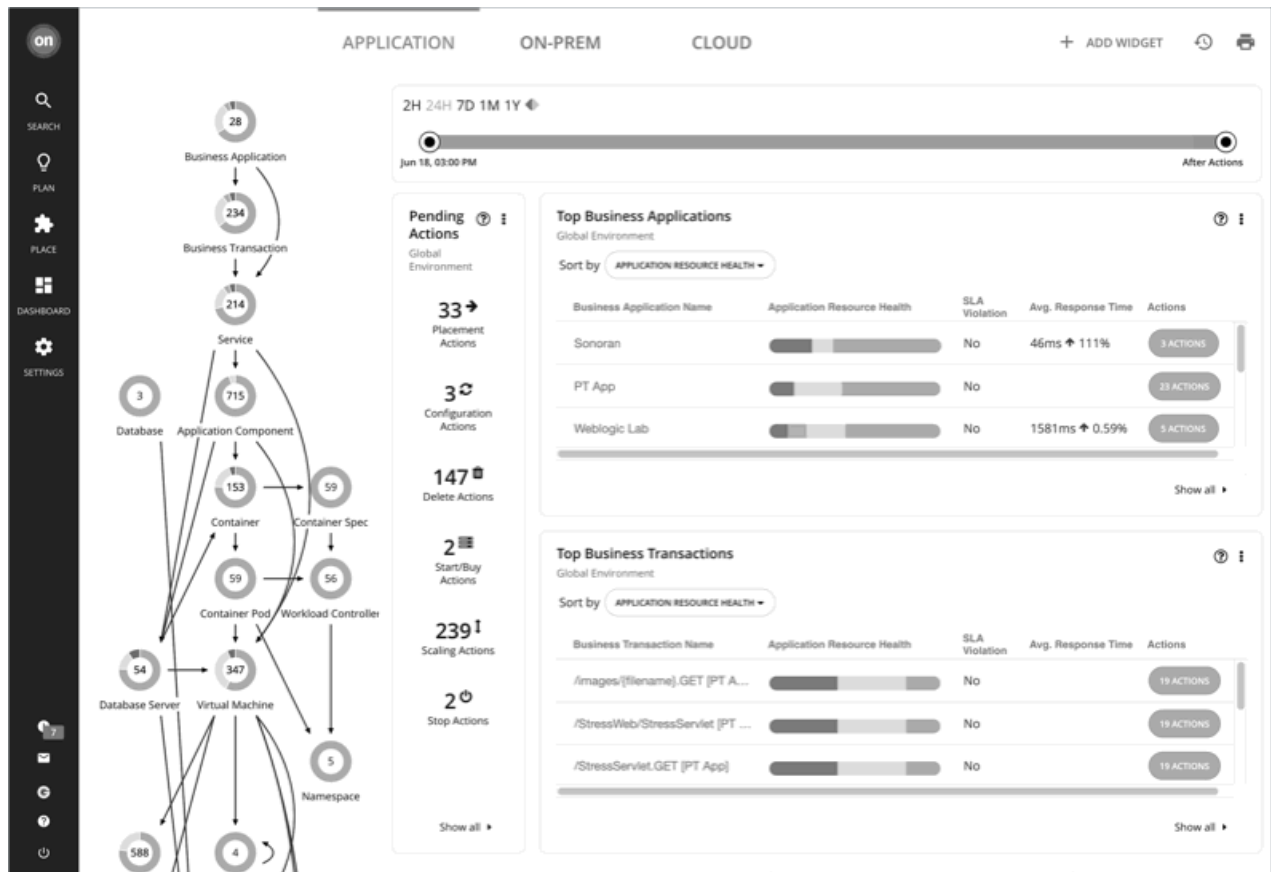
Getting Home



Wherever you are in your Turbonomic session, you can always click the Home icon to return to the **Home Page**.

APPLICATION View

The **APPLICATION** view presents your environment in the context of your [Business Applications](#). See the overall health of your applications, examine any performance and compliance risks, and execute the actions that Turbonomic recommends to address these risks.



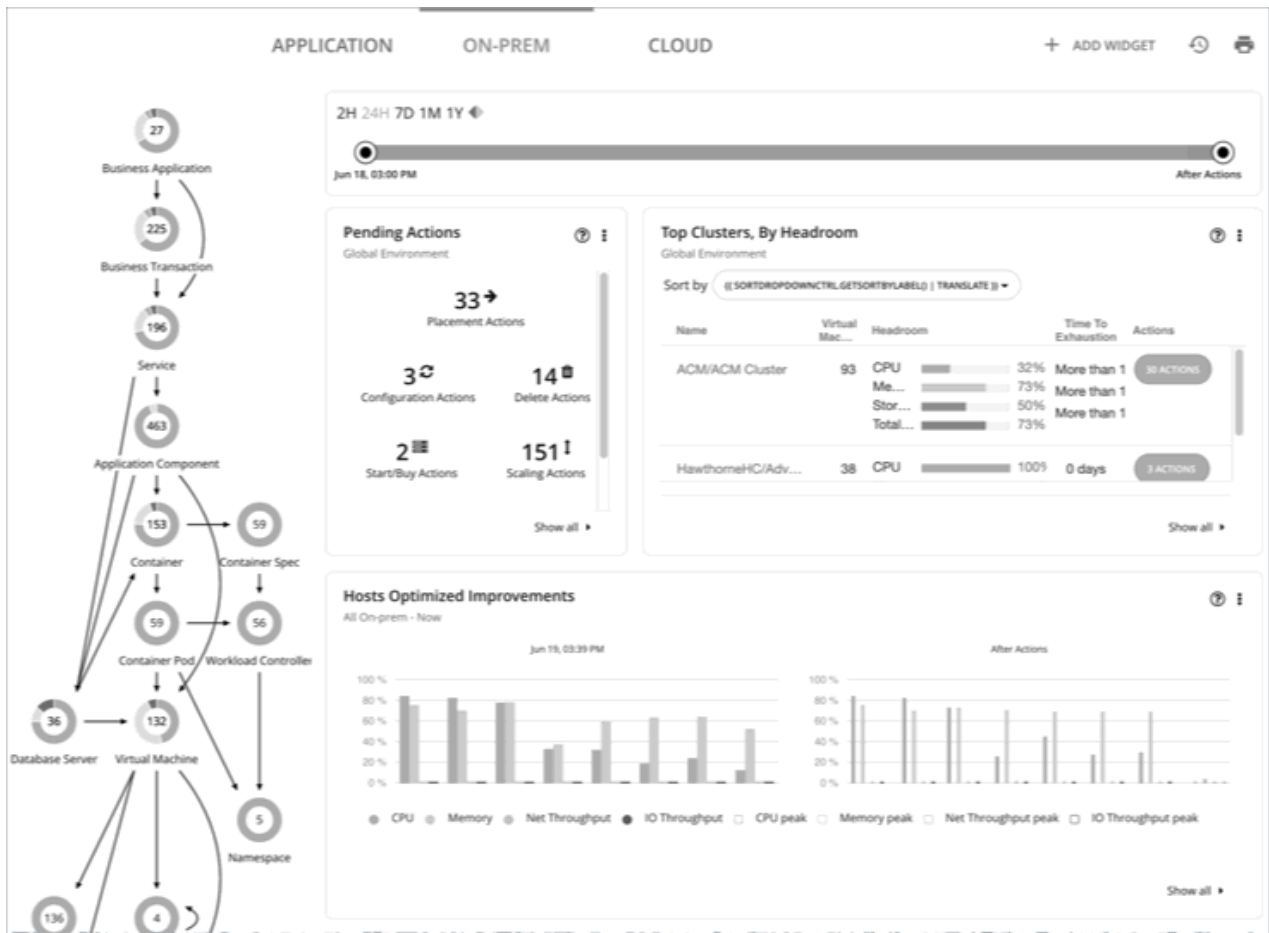
This view also shows the [Business Transactions](#) and [Services](#) that make up your Business Applications. You can see finer details and set SLOs at these levels of the application model.

Note:

If certain application entities do not stitch into the supply chain infrastructure for some reason, Turbonomic displays them in both the ON-PREM and the CLOUD views. Once Turbonomic can stitch them into the infrastructure, it classifies them according to the class of the infrastructure and displays them in the correct views.

ON-PREM View

When you set your session to the Global Scope, you can then select the **ON-PREM** view. This shows an overview of your on-prem environment. If you don't have any workload on the public cloud, then you should use this as your starting point for a Turbonomic session. If you have a hybrid environment (on-prem and on the public cloud), then you can refer to this view to see a detailed on-prem overview.



The Supply Chain shows all the on-prem entities in your environment. The charts show details about your environment, including:

- Overviews of pending actions

When appropriate, the overview includes estimated one-time savings or costs associated with the actions.

- Top Cluster utilization

See a list of the most utilized clusters. The chart shows these clusters, along with a count of actions for each. To drill down into the cluster details, click the cluster name. To see and execute the specific actions, click the **ACTIONS** button for that cluster. To see all the clusters in your environment, click **SHOW ALL**.

- Optimized Improvements

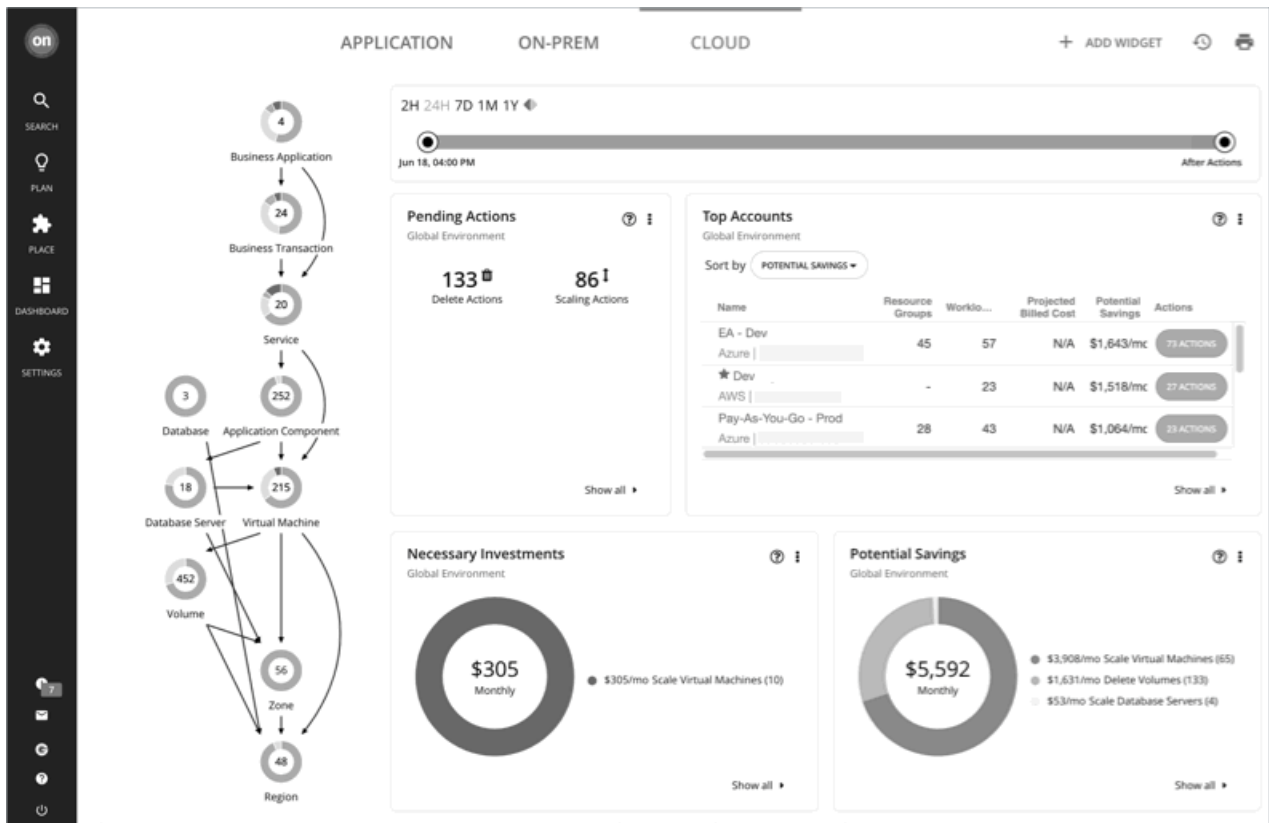
Compare current resource utilization with the utilization you would see if you choose to execute all the pending actions.

- Action history

You can see a history of all actions that have been recommended and executed, or of just the actions that have been accepted and executed.

CLOUD View

When you set your session to the Global Scope, you can then select the **CLOUD** view. This shows an overview of your cloud environment. If all your workload is on the public cloud, then you should use this as your starting point for a Turbonomic session. If you have a hybrid environment (on-prem and on the public cloud), then you can refer to this view to see a detailed cloud overview.



To view cloud cost information, you must have one or more public cloud targets set up in your Turbonomic installation. For information about setting up public cloud targets, see [Private Cloud](#).

In addition, to view full cost information in AWS, you must have created a Cost and Usage report in your AWS account and you must store it in an S3 bucket. For details, see [Displaying AWS Spend In Turbonomic](#).

In this view, the Supply Chain shows all the cloud entities in your environment. The charts show details about your cloud environment, including:

- Overviews of pending actions

The overview includes the estimated monthly savings or cost associated with those actions.

- Top Accounts utilization

See a list of the most utilized public cloud accounts. The chart shows these accounts, along with an estimate of the monthly cost for each. To see all the cloud accounts in your environment, click **SHOW ALL**.

- Necessary Investments and Potential Savings

For the current set of pending actions, these charts show the impact in dollar value. Necessary Investments are from actions to provision more workloads or to resize workloads up. Potential Savings are from actions to resize down, or to purchase RI resources and put them into active use.

- Charts that show your current Reserved Instance strategy. For details, see [RI Charts](#).
- Billed Cost by Service

This chart shows costs over time for each cloud service that you use in your cloud accounts. For example, you can see the cost for AWS CloudWatch, compared to the cost for AWS S3 storage.

Tracking Cloud Cost

Cost for Services

Turbonomic uses the billing reports from your cloud service providers, as they are associated with your cloud targets. Turbonomic parses these reports to get cost breakdowns by service, service provider, Azure Resource Group, and cloud account. You can see cost data in charts such as:

- Cloud Estimated Cost
- Cost Breakdown by Cloud Accounts, Component, or Service Provider
- Expenses

Workload Expenses

Workloads are the VMs running in your environment, or other hosted processes such as database servers and containers. Turbonomic tracks the following expenses for your workloads:

- Compute

For compute expenses Turbonomic uses hourly expense per template as specified in the associated public cloud account.

- Storage

Turbonomic discovers the storage tier that supports a given workload, and uses the tier pricing to calculate storage cost.

- License

For AWS environments, Turbonomic can calculate OS costs. To calculate the OS cost for a VM, Turbonomic subtracts the template cost from the published workload cost. It assumes the difference is the license cost for that workload. If the OS is open source, then there will be no difference, and license cost is zero.

For Azure environments, Turbonomic can track OS costs for existing VMs. For RI Buy actions, Turbonomic does not include the OS cost. For more information about Azure RIs, see [Azure Enterprise Agreements](#).

- IP

For some workloads, you might use IP services that incur a cost. For example, your cloud provider might charge to grant a static IP to a VM. On AWS environments Turbonomic can include that cost in its calculation and analysis.

Turbonomic uses this cost information when making VM resize and placement decisions. You can see this information in Expenses charts.

Costs for Dedicated Tenancy on AWS

When you create VMs on AWS, you can specify their tenancy. When you specify Dedicated Tenancy (DT), the VMs you create are Amazon EC2 instances running on hardware that is dedicated to a single customer. To understand DT in the context of Turbonomic, you should consider:

- For AWS, the Turbonomic supply chain shows an Availability Zone as a Host. The supply chain does not indicate whether certain VMs have tenancy dedicated to specific resources in the given availability zone. Also, Turbonomic does not discover or show the costs for dedicated hosting of your workloads.
- Pricing for DT workloads is different than pricing for Shared Tenancy. Turbonomic does not discover that difference, and uses Shared Tenancy cost for the DT workloads. In action descriptions, the listed savings or investments will be based on Shared Tenancy costs.
- Turbonomic discovers the true costs of RIs for DT workloads. However, because the on-demand VM costs are based on Shared Tenancy, Turbonomic can overstate the savings you would get for purchasing and using RI capacity. In most cases, recommendations to purchase RIs will be correct. However, the time to achieve ROI could take longer than action descriptions and charts indicate.

- Some instance types that are valid for Shared Tenancy are not valid for DT. To see which instance types are valid for your DT VMs, consult the AWS documentation or your AWS representative.
- Under some circumstances Turbonomic can recommend changing a workload to a valid instance type for the tenant, even though the current type is already valid. This can happen when the instance type is not included in the Offer File for the tenancy. For example, assume the t3a template family does not support dedicated tenancy. However, assume that the user created a t3a instance with dedicated tenancy in the EC2 console. In that case, Turbonomic will see this as a misconfiguration and recommend changing to a different instance type.

To address these issues, you can create groups that set a scope to your DT workloads. For example, you can use naming conventions, tagging, or other means to identify your DT workloads. Then you can create dynamic groups based on those indicators. With those groups, you can create policies and dashboards that correspond to the differences you see in your DT environment. Use this approach to address issues for:

- Available Instance Types

To resize a workload, Turbonomic generates an action to change that workload to a different instance type. Because Turbonomic does not discover the difference between instance types that are valid for DT and for Shared Tenancy, it can recommend scaling a DT workload to an unavailable instance type. To avoid this, create a policy for the DT group, and exclude the unavailable instance types.

- Displaying Costs

Turbonomic charts show the costs for your environment. If the scope includes Dedicated Tenancy workloads, then the calculated cost will be incomplete. For example, since AWS does not return pricing data for converted RIs (that is, RIs that have been exchanged at least once) that are on *All Upfront* payment plans, Turbonomic does not include such RIs in its calculations of RI utilization or cost.

Use scope to minimize this effect. You can create separate dashboards for your DT and Shared Tenancy workloads.

Resizing Cloud Workloads

To resize a workload (for example, a VM or an RDS instance) on the cloud, Turbonomic chooses the cloud tier that best matches the workload requirements. This can be to reduce cost by choosing a smaller tier, or it can be to assure performance by choosing a larger tier. To accomplish the resize, Turbonomic actually moves the workload to the new tier. This can include moving to a new availability zone.

Note that resize decisions also take into account the discount you can realize by using RI purchases. Turbonomic can recommend to purchase more RI resources. When considering workload resize actions, Turbonomic can recommend resizing to a larger RI tier because the overall cost will be less.

As it considers a resize, Turbonomic also considers the storage and network requirements. Even if the compute resources are underutilized on a workload, if the available tiers cannot support the workload's storage or network requirements then Turbonomic will not recommend the change.

Note:

In AWS environments, under certain circumstances VM resizing can fail. If the restart of the VM initially fails, Turbonomic waits 30 seconds and tries to restart again. Turbonomic will try to restart up to four times. If the restart still fails, Turbonomic assumes the VM cannot start up on the new tier, and it restarts the VM on the old tier.

Scaling on the Public Cloud

On the cloud, scaling actions change the VM to a different instance type. These can include:

- Changing a VM to an instance type with different capacity
- Changing on-demand to RI

For these actions, the action list shows the current cost for the source workload, and also the projected cost given the change. To show the current cost, Turbonomic uses the actual costs for that workload.

However, to show the projected cost it uses an estimate based on average utilization for the VM, for the costs of the given tier.

Note that scaling to an RI can result in running the VM on a larger instance when the cost is lower. This might occur even though the VM does not need that capacity and there are other smaller tiers available.

In Azure environments, there are circumstances where a VM resize can be especially disruptive. In a given region, the infrastructure can be made up of different clusters that have different sets of underlying hardware. Further, some tiers that are available in the given region are only available on different clusters. If Turbonomic recommends resizing from a tier on one cluster, to a tier on another cluster, then the resize action can take longer to complete than usual.

In both Azure and AWS environments, Turbonomic conforms to specific instance requirements as it generates resize actions. For more information, see:

- [Azure Instance Requirements](#)
- [AWS Instance Requirements](#)

Reserved Instances (RIs)

Turbonomic analysis takes advantage of AWS and Azure Reserved Instances (RIs) to calculate optimal workload placement and to arrive at the best possible costs for your deployments on the cloud.

Note:

For AWS environments, under very rare circumstances, you can have RIs on payment plans that do not resolve to 1-year or 3-year terms. In this case, AWS does not return pricing data for those RIs. Turbonomic does not include such RIs in its calculations of RI utilization or RI cost.

RI Charts

The Cloud View in the Homepage includes the following charts that show RI data:

- [Pending Actions](#)

If Turbonomic has found actions you can take to improve performance or to reduce cost, then you can see an overview of them in the Pending Actions chart. To see a listing of the specific actions, click **Show All** at the bottom of the chart. For more about actions, see [Turbonomic Actions](#).

- [RI Utilization](#)

This chart shows how well you have utilized the Reserved Instance inventory. The chart compares the capacity for all Reserved Instances versus the RI consumption by virtual machines.

- [RI Coverage](#)

This chart compares the capacity of your current VM workload to the capacity of workload that is covered by RIs.

If you have a high percentage of on-demand workload, then you should be able to reduce your monthly costs by increasing RI coverage. To increase coverage, you resize workloads to instance types that have existing RI capacity. If you need more RI capacity, then Turbonomic will recommend the RIs that you should buy.

- [RI Inventory](#)

This chart lists the RI instance types that are active in your inventory. To see more information, click **Show All** at the bottom of the chart.

- [Recommended RI Purchases](#)

This chart shows the projected inventory of pending RI purchases as generated by Turbonomic. To see more information, click **Show All** at the bottom of the chart.

RI Purchases

Turbonomic can recommend that you purchase RI capacity to reduce costs for your current workload. The analysis looks at workload history for template families to identify RI candidates. This considers the count of workloads in a family, their hours of active-state condition, and RI costs. If a workload shows stable utilization over time, then Turbonomic identifies it as an RI candidate, and it recommends purchasing RI capacity for that workload. To ensure enough historical data for the analysis, Turbonomic generates RI Buy actions on a two-week cycle. It also generates a new set of RI Buy actions if you change the RI inventory, or if you restart Turbonomic.

Be aware of the following:

- Different types of RIs have different costs, so the choice between using on-demand or RI pricing can vary depending on the RI Pricing configuration in your Budgets and Costs settings. For more information, see [RI Purchase Profile](#).
- Turbonomic can only estimate the cost that would result if you execute pending RI Buy actions. This is because the full data is only available after you actually purchase the RIs. Estimates reflect costs you would see after scaling workloads to the newly purchased RI capacity. For scaling to already-purchased RIs, the chart reflects the actual costs.
- As Turbonomic calculates actions to purchase RI capacity, it assumes that any other pending actions for the workload will also be executed. For example, assume a workload running on an r4.xlarge template. If Turbonomic recommends changing that instance type to an m5.medium, it can recommend that you purchase an m5 RI to cover the workload and reduce costs. This purchase could be on a region that currently doesn't have any m5 workloads — The purchase recommendation assumes you will move the workload to that other region.
- Turbonomic uses a weighted history of workload activity and that suspended VMs are also considered. The longer ago that the workload was suspended, the less weight it has in the RI Buy calculation.
- For AWS RIs:
 - For environments that use the *Instance Size Flexible* rules, Turbonomic can recommend that you buy multiple RIs of smaller instance types to cover the resource requirements of larger instance types. For example, rather than buying one t2.small RI, Turbonomic can recommend that you buy four t2.nano RIs to offer an equivalent discount.
 - For environments that consolidate billing into Billing Families, Turbonomic recommends purchases for RIs that are within the given billing family. For more information, see [AWS Billing Families](#).

Support for Government Workloads

[AWS GovCloud \(US\)](#) and [Azure Government](#) provide dedicated regions for US government customers and their partners to architect secure cloud solutions and meet regulatory and compliance requirements.

Turbonomic discovers workloads in these regions when you add the required accounts as targets. For details on the required accounts, see [AWS GovCloud Targets](#) and [Azure Government Targets](#).

Discovered workloads include:

- AWS VMs (including auto-scaling groups), volumes, database servers, and spot instances
- Azure VMs (including availability/scale sets), volumes, and SQL databases

Turbonomic recommends actions on VMs, volumes, and SQL databases to address performance issues and optimize costs.

Note:

Turbonomic currently does not support Azure Government integration with Application Insights. You can add accounts for Azure Government and Application Insights as targets, but Application Insights will only return performance data for non-government workloads.

Information in Charts

Use the following charts to view information about your government accounts and workloads.

- **Top Accounts** chart

Use the Top Accounts chart as a starting point. This chart shows the following:

- Azure Government subscriptions discovered via the service principal and EA accounts that you have added as targets
- AWS GovCloud master and member accounts that you have added as targets. Accounts with a star symbol are master accounts.

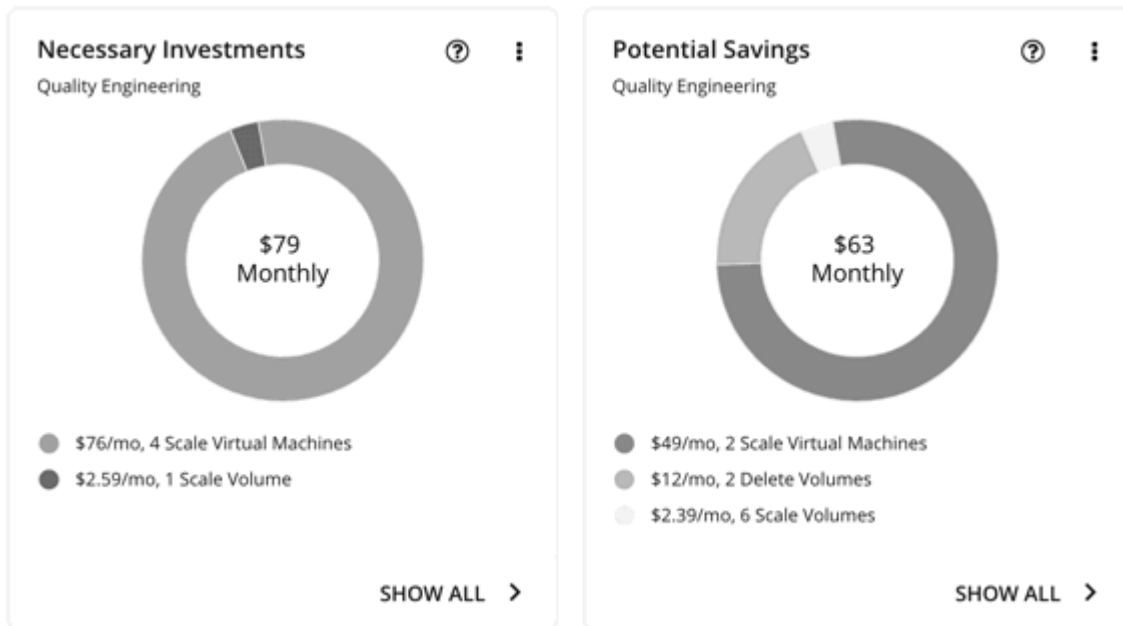
Top Accounts						?	:
Global Environment							
						SORT BY: POTENTIAL SAVINGS ↑	
Name	Resource Groups	Worklo...	30-Day Cost ⓘ	Potential Savings ⓘ	Actions		
Gov Pay-As-You-Go							
Azure US Government [Progress Bar]	2	1	N/A	\$0.96/mo	1 ACTION		
GovEA - Development 2							
Azure US Government [Progress Bar]	2	1	\$1.09/mo	\$1.11/mo	1 ACTION		
★ Development							
AWS GovCloud (US) [Progress Bar]	-	9	N/A	\$14/mo	4 ACTIONS		
Quality Engineering							
AWS GovCloud (US) [Progress Bar]	-	16	N/A	\$64/mo	17 ACTIONS		
EA - ParkMyCloud							
Azure Global [Progress Bar]	6	8	\$70/mo	\$132/mo	5 ACTIONS		

SHOW ALL >

For an AWS GovCloud account, the 30-day cost is shown as **N/A** since invoicing for that account is managed through an associated *AWS standard account*. Adding this standard account as a target is optional. When added, it appears in the Top Accounts chart and shows the total 30-day cost for the GovCloud account and the standard account itself.

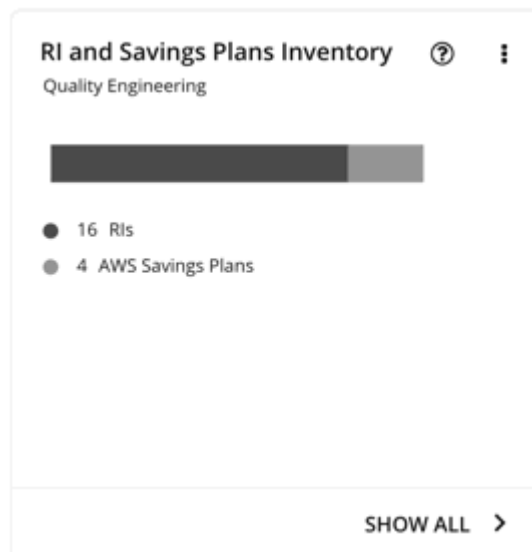
- **Necessary Investments** and **Potential Savings** charts

Set the scope to a government account or subscription, and then see the Necessary Investments and Potential Savings charts to evaluate the costs you would incur or save if you execute all the pending actions for your government workloads.



- **RI and Savings Plans Inventory** chart

The government accounts that you added as targets enable Turbonomic to gain full insight into the AWS/Azure RIs and AWS Savings Plans that you have purchased for your government workloads. Even as you selectively add secondary targets, Turbonomic remains aware of all RIs and Savings Plans, and how they are utilized across the board. This increases the accuracy of the allocation and purchase recommendations that Turbonomic generates for your government workloads.



Workload Planning

You can run an Optimize Cloud plan to identify performance and efficiency opportunities for existing government workloads, or a Migrate to Cloud plan to migrate government VM groups to another cloud provider.

For on-prem clusters, you can run a Migrate to Cloud plan to see how you can safely migrate the VMs in these clusters to a government account/subscription and region.

Support for Azure App Service

When you add an Azure account, Turbonomic discovers the app services and plans that make up your [App Service](#) deployment. In the supply chain, app services appear as Service entities, while plans that define the underlying compute resources for app services appear as Application Components.

To discover app services and plans, Turbonomic requires the same permissions for monitoring other Azure workloads.

Note:

App Service analysis and optimization will be introduced in a future release.

Configuring Targets

A target is a service that performs management in your virtual environment. Turbonomic uses targets to monitor workload and to execute actions in your environment. When you configure a target, you specify the address of the service, and the credentials to connect as a client to it.

For each target, Turbonomic communicates with the service via the management protocol that it exposes — The REST API, SMI-S, XML, or some other management transport. Turbonomic uses this communication to discover the managed entities, monitor resource utilization, and execute actions.

To configure a target, you will choose the target type, specify the target's address, and then provide credentials to access the target.

After you configure a target and add it to your installation, Turbonomic validates the connection, and then discovers the entities that target manages.

Note:

Turbonomic regularly checks that your targets are valid. If it discovers that a target is invalid it then posts that status to the user interface. Under some circumstances, the target can become valid again, but the status does not update. If you see an Invalid message for a given target, try to manually validate the target again (click **VALIDATE**).

Configuring a Target

1. Navigate to the Settings Page.



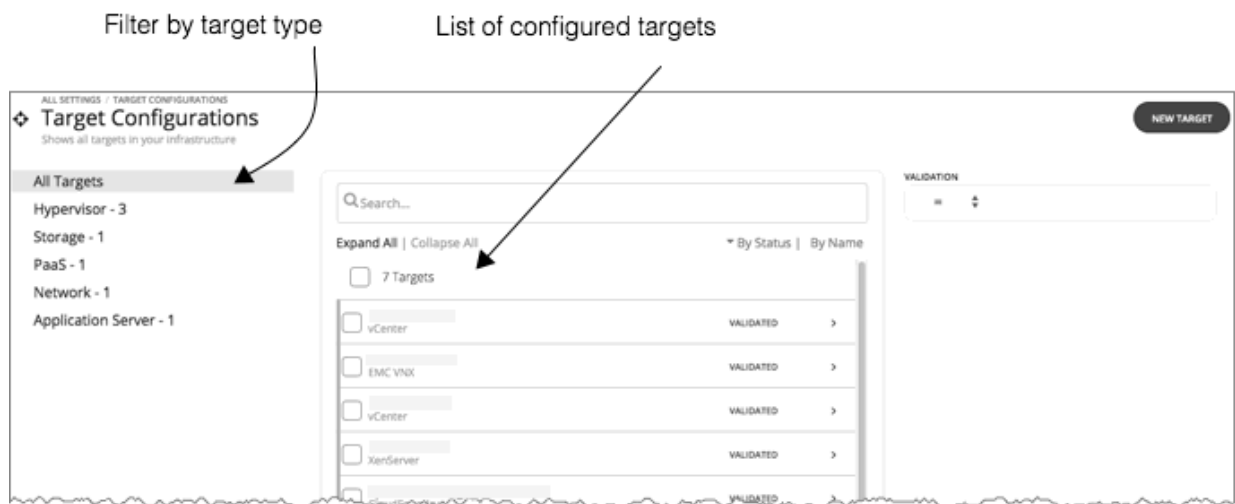
Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. Choose Target Configuration.



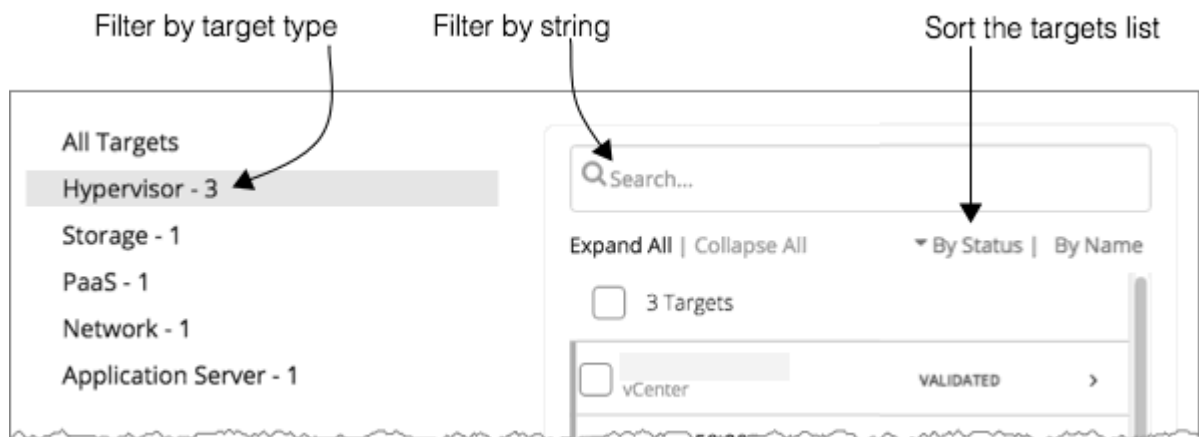
Click to navigate to the Target Configuration Page.

3. Review the list of targets.



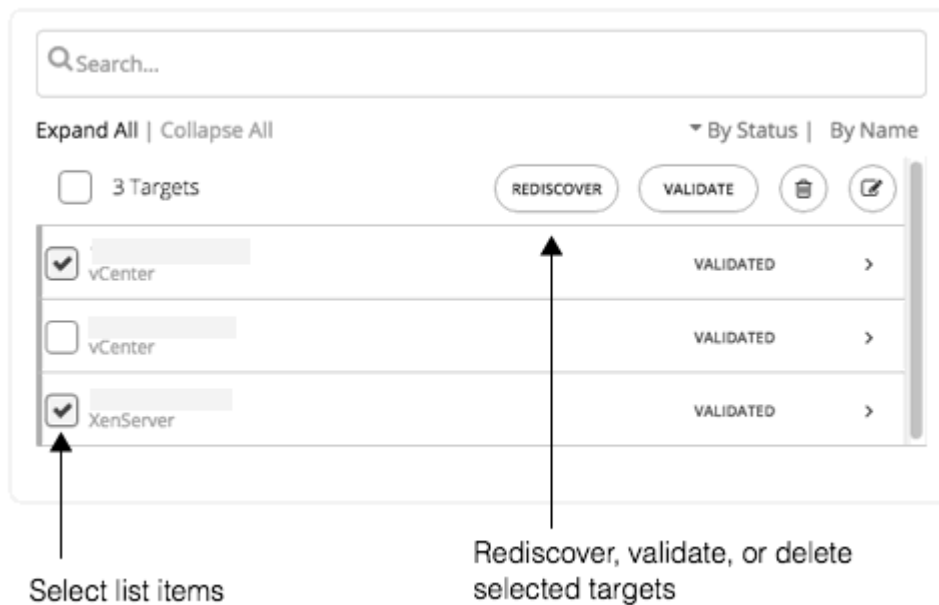
This page lists all the targets that you currently have configured for Turbonomic. You can inspect these targets, you can edit them (change address and credentials), and you can add a new target to Turbonomic.

4. Filter the list of targets.



To work with a long list of targets, you can filter by the target type. You can also type a string in the **Search** field to filter the list, and you can sort the list by target status or target name.

5. Select one or more targets to work with.



When you select a target you can:

- Rediscover — Direct Turbonomic to fully discover the entities that this target manages. This will rebuild the topology that is associated with this target.
- Validate — Direct Turbonomic to validate its connection with the target. For example, if you create a new user account on the target, you can edit the target connection to use that account, and then revalidate.
- Delete — When you delete a target, Turbonomic removes all the associated entities from its model of the inventory.

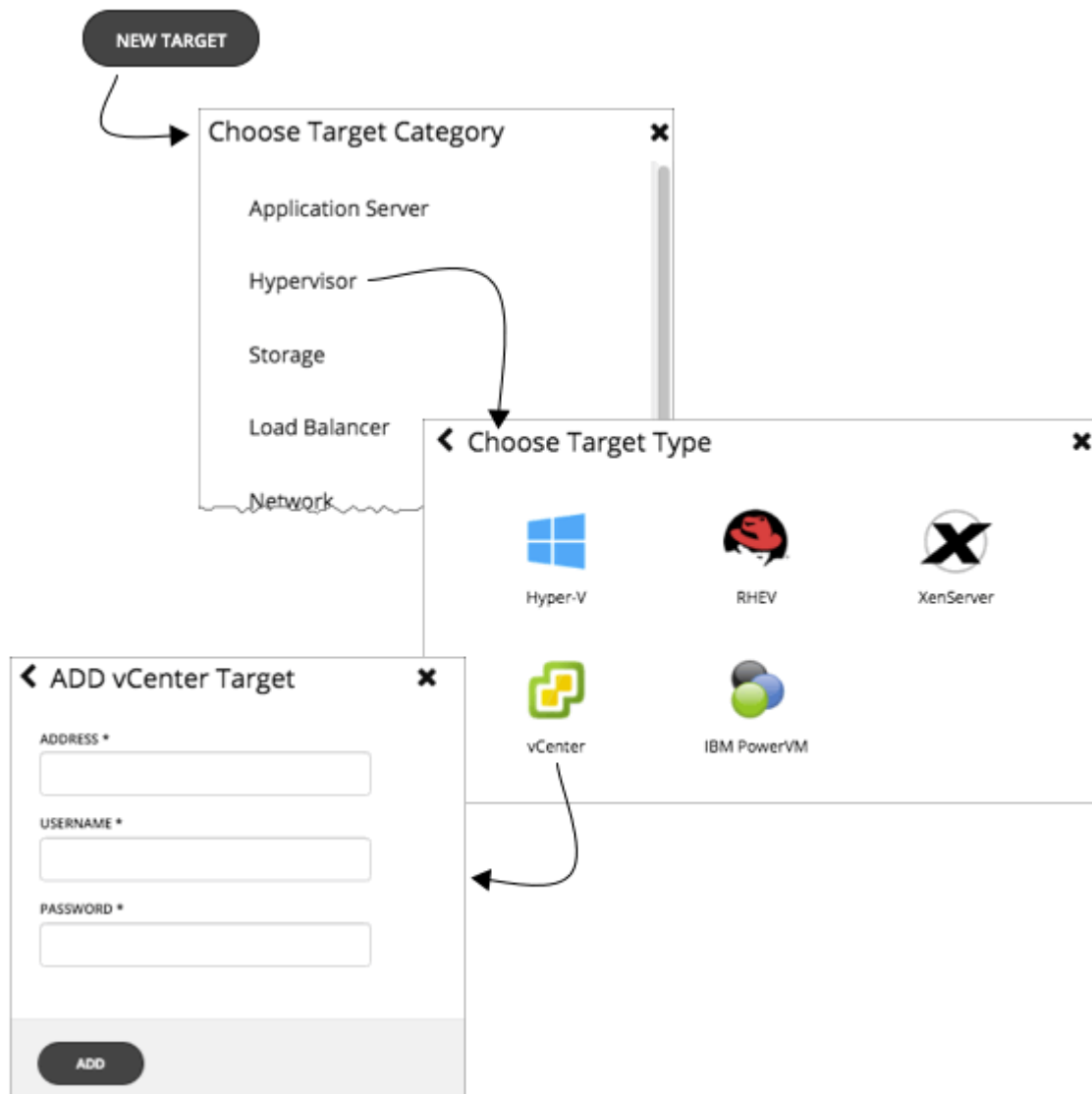
6. Expand an entry to see details, or click the entry to edit the target's configuration.

For example, if you entered the wrong username or password, you can change those credentials and validate the target again.

Click to expand/collapse details



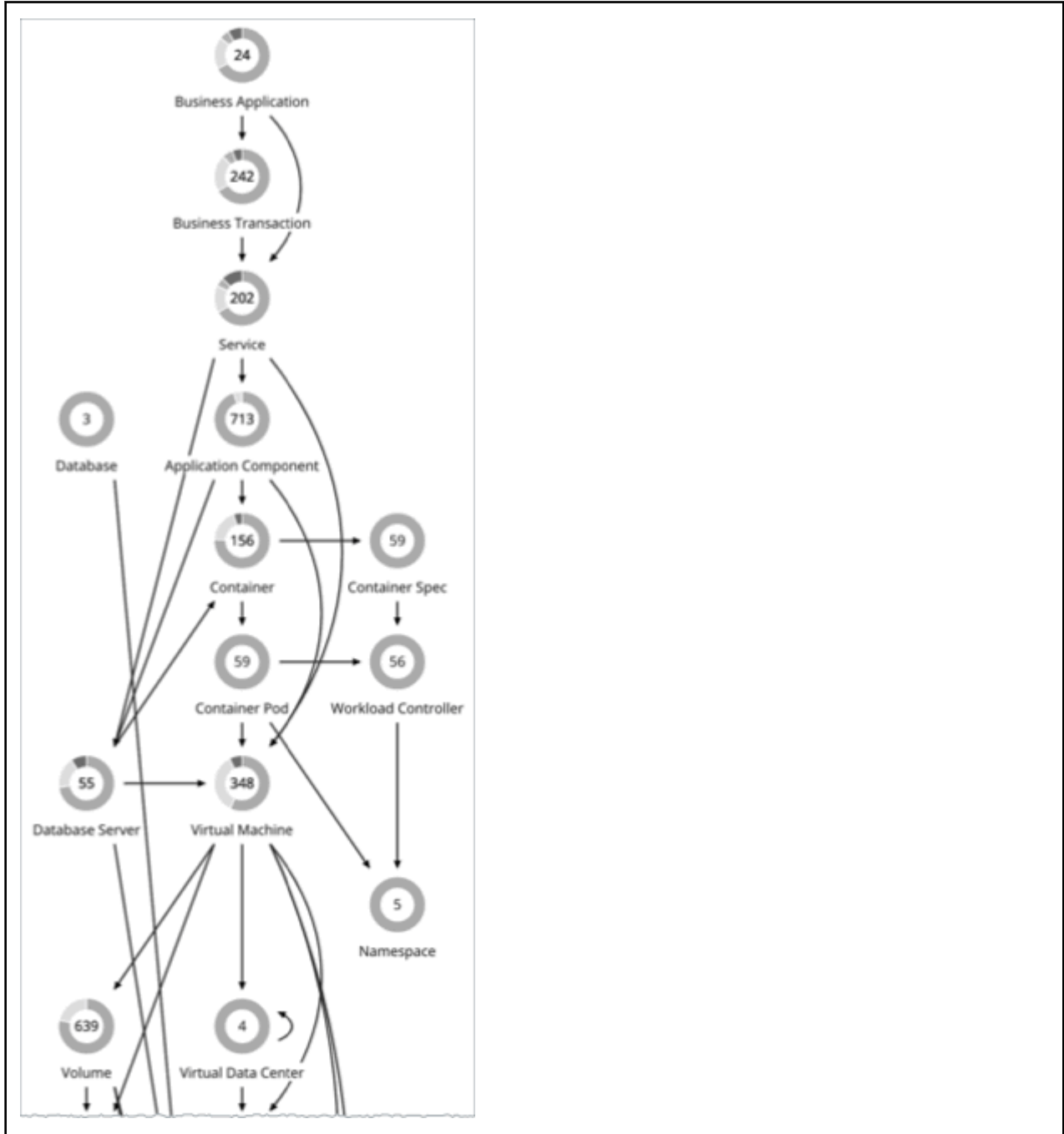
7. Create a new target and add it to Turbonomic.



First, select the type of target to add. Then for the type you choose, select the specific target technology. For example, select Hypervisor/vCenter to add a VMware vCenter Server target. Then provide the address and credentials for that target.

For more details, including a list of supported targets and configuration requirements, see [Chapter 6, “Target Configuration,”](#) on page 217.

Supply Chain of Entities



To perform Application Resource Management, Turbonomic models your environment as a market of buyers and sellers linked together in a supply chain. This supply chain represents the flow of resources from the datacenter, through the physical tiers of your environment, into the virtual tier and out to the cloud. By managing relationships between these buyers and sellers, Turbonomic provides closed-loop management of resources, from the datacenter, through to the application.

Reading the Supply Chain

By looking at the Supply Chain, you can see:

- How many entities you have on each tier

Each entry in the supply chain gives a count of entities for the given type.

- The overall health of entities in each tier

The ring for each entry indicates the percentage of pending actions for that tier in the datacenter. Ring colors indicate how critical the actions are - Green shows the percentage of entities that have no actions pending. To get actual counts of pending actions, hover on a ring to more details.

- The flow of resources between tiers

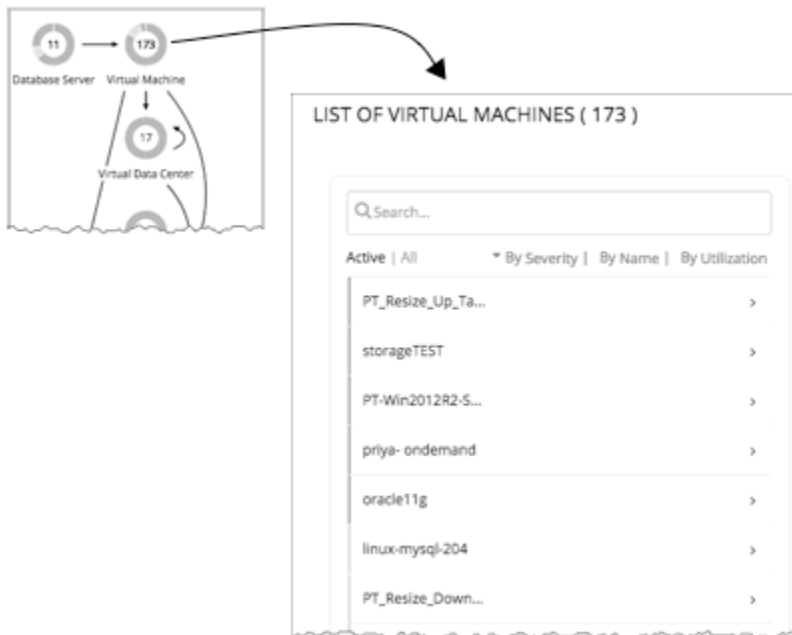
The arrow from one entry to another indicates the flow of resources. For example, the Virtual Machine entry has arrows to Hosts and to Storage. If the VMs are running in a Virtual Data Center, it will have another arrow to that as well. This means that your VMs consume resources from hosts, storage, and possibly from VDCs.

Listing Entities From the Home Page

The Supply Chain shows the relationships of entities in your environment. When you're on the **Home Page** with a global scope, the supply chain filters its display according to the view you have chosen:

- APPLICATIONS – All your [Business Applications](#)
- ON-PREM – All your on-prem entities
- CLOUD – All your entities on the public cloud

To see a list of entities, click an entity tier in the Supply Chain.



Working With a Scoped View

By default, the **Home Page** shows a Global view of your environment. To drill down into specifics of your environment, you can set a scope to your Turbonomic session. A scoped view shows details about the specific entities in that scope.

Once you have set a scope, you can use the Supply Chain to zoom in on a related tier to see details about the entities on that tier.

If you find the current scope to be useful, you can save it as a named group. Using named groups is an easy way to return to different scopes that you have saved.

Scoping the Turbonomic Session

The default scope for the **Home Page** shows an overview of the global environment. What if you want to focus on less than the global environment? Assume you are responsible for a subset of workloads in your environment. This could be:

- Workloads managed on a single host cluster
- The workloads in a single datacenter
- A custom group of workloads you have created in Turbonomic

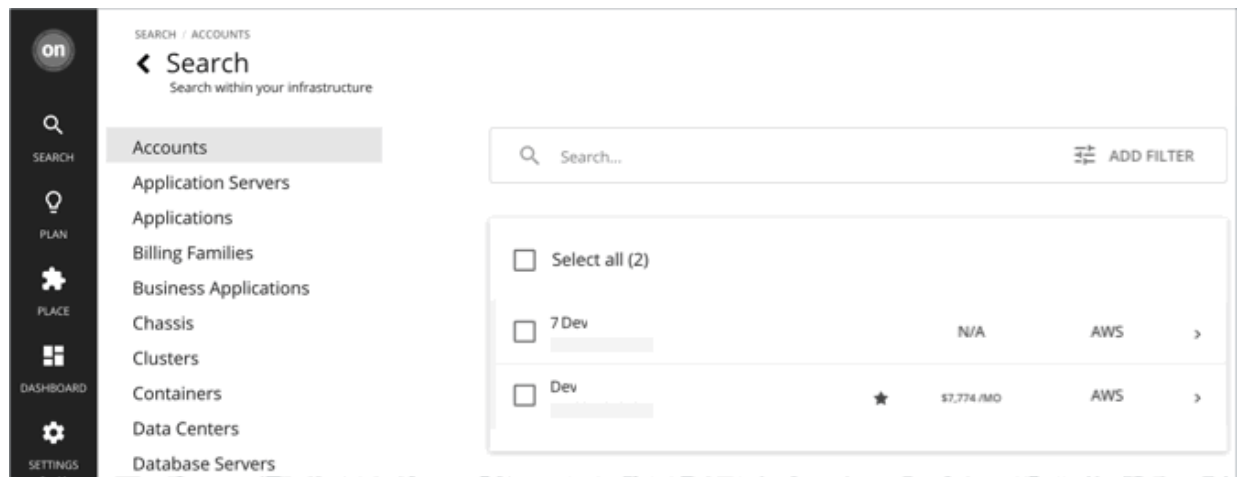
It's easy to set the session scope so that Turbonomic zooms in on the part of the environment that you want to inspect. Once you set the scope, you can get a quick picture of system health for that scope. If you find a certain scope to be useful, you can save it as a named group that you can return to later.

1. Navigate to the Search Page.



Click to navigate to the Search Page. This is where you can choose the scope you want.

2. Choose the type of entities to search.



In the Search Page, choose a type of entities that you want to search through. Find the list of entity types on the left. Select **All** to search the complete environment. Or you can focus on entities by type, by groups, or by clusters. When you select an entity type, the page updates to show all entities of that type.

3. Use **Search** to filter the listing.

For example, if you're showing **All** and you search for "Development", then you will see all clusters, groups, and entities with "Development" in their names.

Search for "Development" to filter the list



4. Expand an entry to see details.

For example, expand a group or an entity to see utilization details and pending actions.

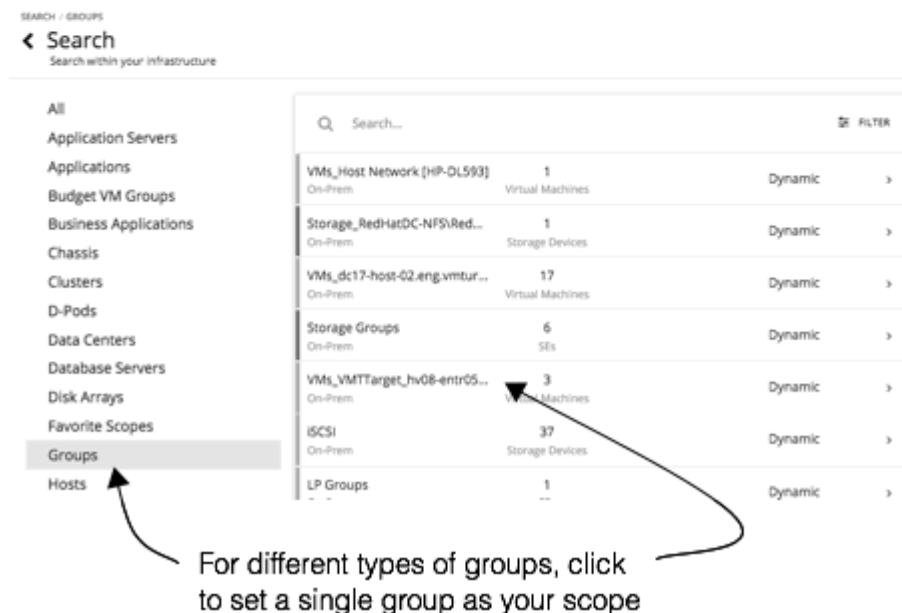
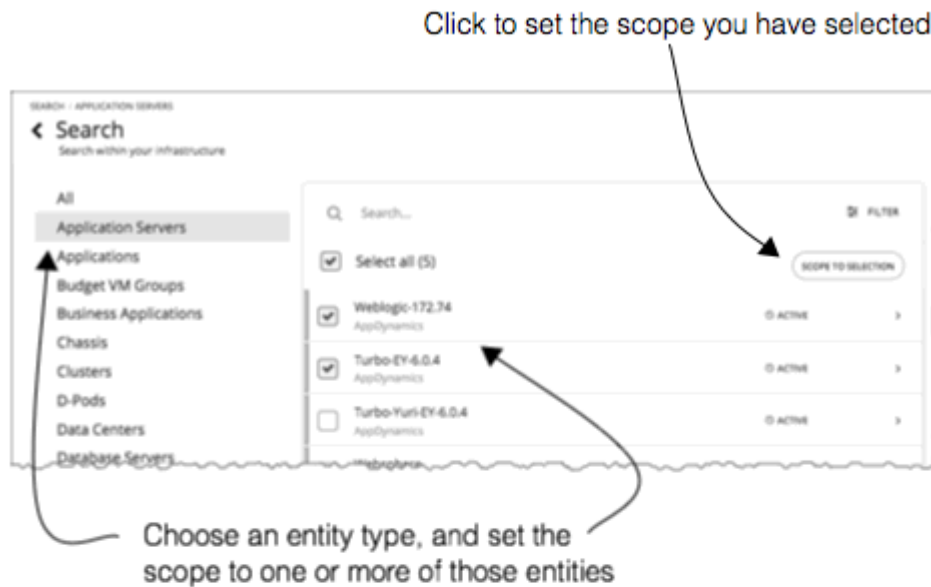
Note:

For hosts in the public cloud, utilization and capacity for host and datacenter resources don't affect Turbonomic calculations. When you expand an entry for a public cloud host, the details do not include information for these resources.

Click to show/hide details



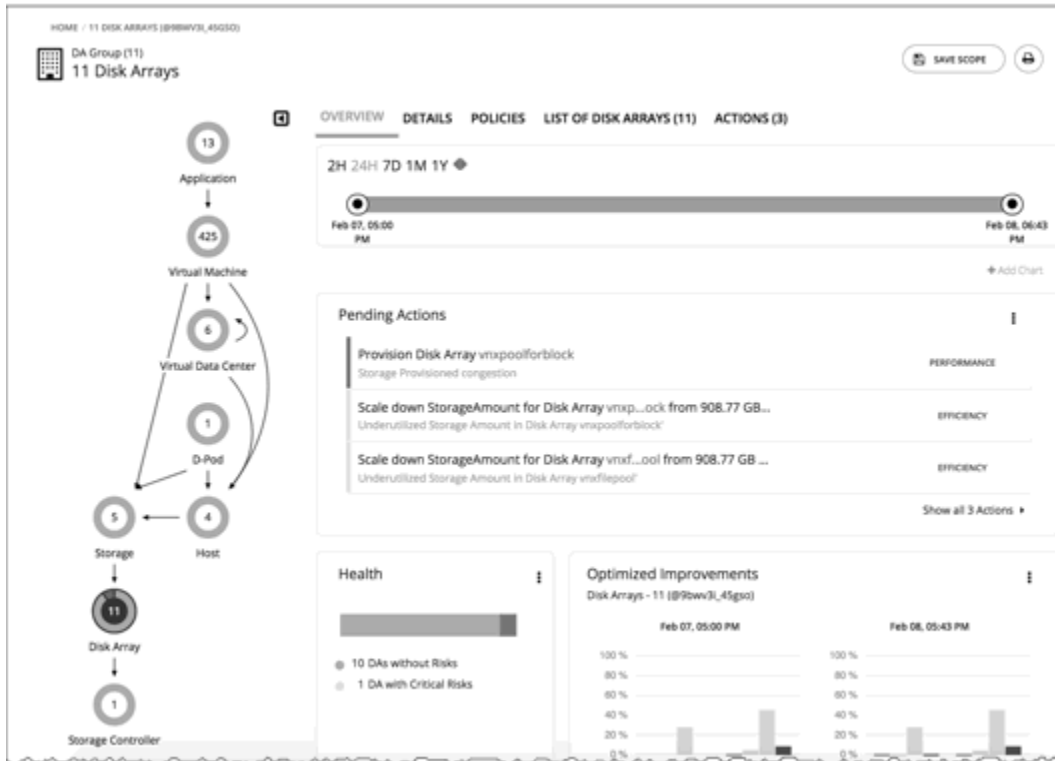
5. Select one or more entries to set the focus of the **Home Page**.



If you choose a category of entities to limit the list, then you can select one or more of the entities for your session scope. After you select the entities you want to include in your scope, click **SCOPE TO SELECTION** to set the session scope to those entities.

If you choose Groups or Clusters, then you can select a single entry to set the scope for your session. When you select an entry in the list, that sets the focus of the **Home Page**. For example, if you select a cluster in the **Search** listing, you set the **Home Page** focus to that cluster. Use the **Home Page** bread crumbs to set a different scope, or you can return to **Search** and set a different scope from there.

Overview Charts



The Overview Charts show your environment's overall operating health for the current session scope. A glance at the Overview gives you insights into service performance health, overall efficiency of your workload distribution, projections into the future, and trends over time.

The charts in this view show data for the current scope that you have set for the Turbonomic session. For the global scope, the charts roll up average, minimum, and peak values for the whole environment. When you reduce the scope (for example, set the scope to a cluster), the charts show values for the entities in that scope.

Some charts included in this view are:

- Pending Actions

See all the actions that are pending for the current scope.

- Health

Quickly see the health of the entities in this scope- How many entities have risks, and how critical the risks are.

- Optimized Improvements

A comparison of utilization in your environment before executing the pending actions, and then after.

- Capacity and Usage

This chart lists resources that are used by the current scope of entities, showing utilization as a percentage of the capacity that is currently in use.

- Multiple Resources

See the utilization over time of various resources that are used by the current scope of entities.

- Top Entities

For example, Top Virtual Machines. These charts list the top consumer entities in the current scope.

- Risks Avoided

Each action addresses one or more identified risks or opportunities in your environment. This chart shows how many risks have been addressed by the executed actions.

- Accepted Actions

This chart shows how many actions have been executed or ignored, and whether they have been executed manually or automatically.

What You Can Do:

- Set scope: See [Scoping the Turbonomic Session](#)
- Create new charts: See [Creating and Editing Chart Widgets](#)

Setting Chart Focus

The charts update to reflect the focus that you have set for your viewing session. While viewing the Overview Charts, you can set the focus in different ways:

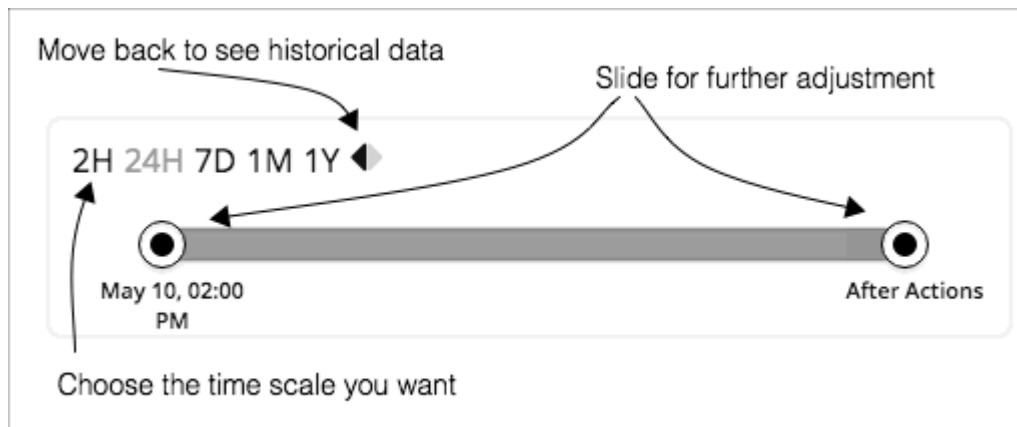
- Set Supply Chain Focus

Choose a tier in the supply chain to set the view focus - see [Navigating With the Supply Chain](#)

- Set Scope

Use **Search** to set the scope of the viewing session - see [Scoping the Turbonomic Session](#)

Chart Time Frame



You can set a time frame from recent hours to the past year, and set that to the charts in the view. Use the Time Slider to set specific start and end times within that range. The green section in the slider shows that you can set the time range to include a projection into the future. For this part of the time range, charts show the results you would see after you execute the current set of pending actions.

For most charts, you can also configure the chart to hard-code the time range. In that case, the chart always shows the same time scale, no matter what scale and range you set for the given view.

Note that Turbonomic stores historical data in its database. As you run Turbonomic in your environment for more time, then you can set a time range to show more history.

Details View

The Details View shows more details about the entities in your session scope. These charts focus on the utilization of resources by these entities, so you can get a sense of activity in that scope over time.



What You Can Do:

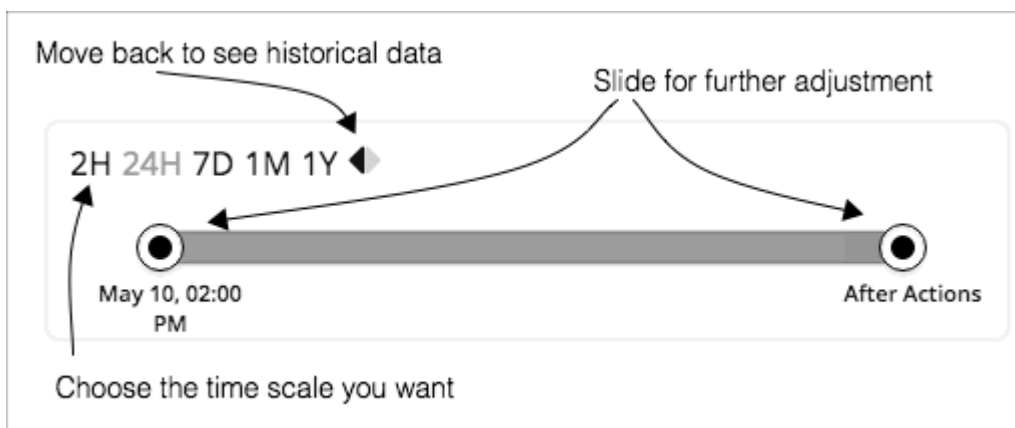
- Set scope: See [Scoping the Turbonomic Session](#)
- Create new charts: See [Creating and Editing Chart Widgets](#)

Setting Chart Focus

The charts update to reflect the focus that you have set for your viewing session. While viewing the Overview Charts, you can set the focus in different ways:

- Set Supply Chain Focus
Choose a tier in the supply chain to set the view focus - see [Navigating With the Supply Chain](#)
- Set Scope
Use **Search** to set the scope of the viewing session - see [Scoping the Turbonomic Session](#)

Chart Time Frame



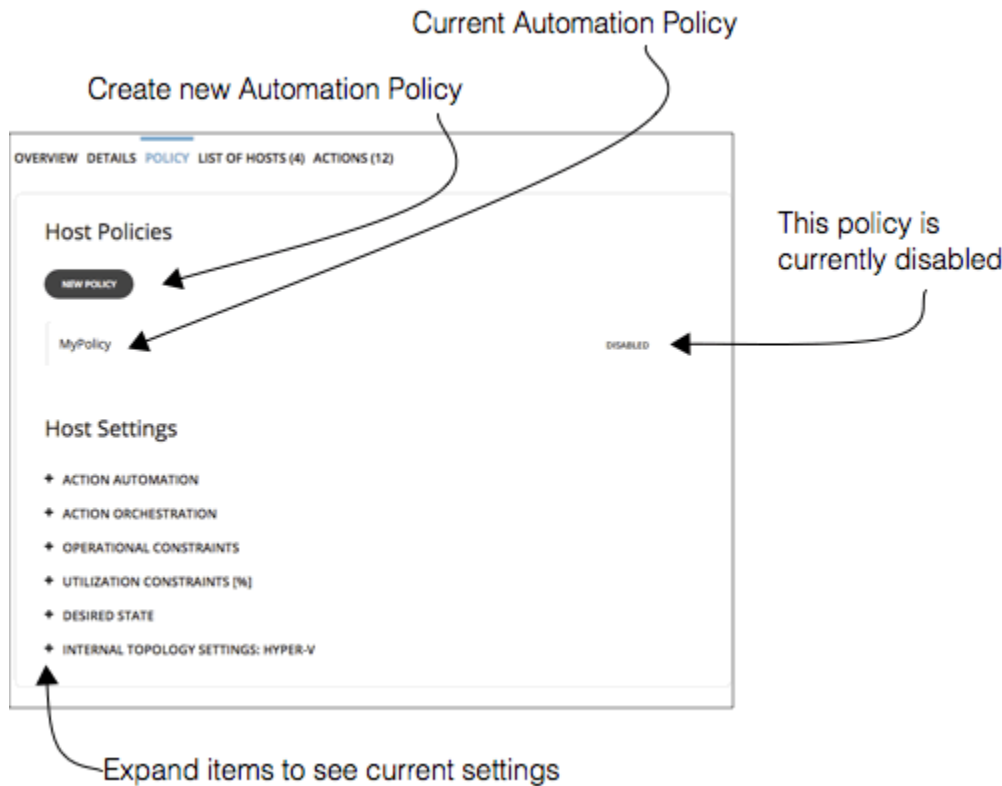
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you can set the time range to include a projection into the future. For this part of the time range, charts show the results you would see after you execute the current set of pending actions.

For most charts, you can also configure the chart to hard-code the time range. In that case, the chart always shows the same time scale, no matter what scale and range you set for the given view.

Note that Turbonomic stores historical data in its database. As you run Turbonomic in your environment for more time, then you can set a time range to show more history.

Scope Policies



The Policy View gives you a look at the Automation Policies that are set for the entities in the current scope. For each policy, you can see whether it has been enabled or disabled. In addition, you can create new policies and apply them to that scope.

To edit a policy, click the policy name. You can then change the policy settings, or enable/disable the policy.

To see the current policy settings, expand a settings category. For each setting, you can see which policy determines the value- Either the default policy or a custom policy that has been applied to this scope.

When you create a new policy, it automatically includes the current scope. You can add other groups to the policy scope if you like. Note that you can enable more than one policy for the same scope. If two policies apply different values for the same setting, then the most conservative value takes effect.

For more information, see [Automation Policies](#).

Entity Placement Constraints

VM Placement Constraints			
- PROVIDERS			
	CURRENT PLACEMENT	OTHER POTENTIAL PLACEMENT	
Host	dc17-host-01.eng.vmturbo.com	4 Hosts	Constraints

Click to see more details

When you drill down to a single entity, you can see details about the entity's relationships in the supply chain. This shows you which entities provide resources to this entity. When considering providers for this entity, you can see the name of each current provider, and how many alternative providers Turbonomic can choose from if the current one becomes overutilized.

Reviewing the constraints on an entity helps you understand the actions that Turbonomic recommends. If an action seems questionable to you, then you should look at the constraints on the affected entities. It's possible that some policy or constraint is in effect, and it keeps Turbonomic from recommending a more obvious action.

Experimenting With Placement Constraints

For each provider or consumer in the list, you can open a **Constraints** fly-out that gives more details about limits on the current element's supply chain relationships.

For example, assume the **PROVIDERS** list shows your VM's **CURRENT PLACEMENT** is on Host A, and for **OTHER POTENTIAL PLACEMENT** you see that Turbonomic can choose from 4 hosts. When you click **Constraints**, the flyout displays a list of host constraints that currently result in the four potential hosts for this VM.

Host Constraints For "Oracle11g-Win-172.32" ✕

When you add constraints, you limit the placement decisions Turbonomic can make for your VM. Remove unnecessary constraints so Turbonomic can discover more placement options.

	CONSTRAINT TYPE	SCOPE NAME	SOURCE	POTENTIAL HOSTS
<input type="checkbox"/>	Cluster boundaries ⓘ	ACM\ACM Cluster	vCenter	4 Hosts
<input type="checkbox"/>	Datacenter boundaries ⓘ	ACM	vCenter	4 Hosts
<input type="checkbox"/>	Datastore Commodity ⓘ	QS4:ACM	vCenter	4 Hosts
<input type="checkbox"/>	Network boundaries ⓘ	NetworkCommodity/Oracle11g-Win-172.32	Turbonomic	12 Hosts
<input type="checkbox"/>	Segmentation Commodity ⓘ	My Placement Policy	Turbonomic	16 Hosts
<input type="checkbox"/>	LicenseAccessCommodity ⓘ	Linux	Turbonomic	70 Hosts

POTENTIAL HOSTS: 4

FIND MORE PLACEMENT OPTIONS

Current count of potential providers

Click to enable constraint simulations

The list information includes:

- CONSTRAINT TYPE

Most constraints are boundaries that are inherent in your environment such as a cluster boundaries or a networks, or the can be constraint rules such as discovered HA or DRS rules authored Turbonomic placement policies (sometimes called *segments*)

- SCOPE NAME

For a given rule or constraint, the scope to which it was applied.

- SOURCE

If this is a discovered constraint, the source shows the type of target that imposes this constraint. For example, for a DRS rule the source will be vCenter.

- POTENTIAL PROVIDERS

For the given constraint, how many providers that constraint allows. To see a list of the potential providers, click the POTENTIAL PROVIDERS value.

To dig deeper into how these constraints affect your entity, click **FIND MORE PLACEMENT OPTIONS**. This puts you into a *simulation mode* that you can use to experiment with changing the effective constraints. For example, you might see that a cluster boundary is limiting your placement possibilities, and you would like the option to place the current VM on other clusters. Armed with this information, you could navigate to Policies and create a Merge Cluster policy.

Use the toggles to turn off various constraints

CONSTRAINT TYPE	SCOPE NAME	SOURCE	POTENTIAL HOSTS
<input type="checkbox"/> Cluster boundaries (i)	ACM/ACM Cluster	vCenter	4 Hosts
<input type="checkbox"/> Datacenter boundaries (i)	ACM	vCenter	4 Hosts
<input type="checkbox"/> Datastore Commodity (i)	QSA/ACM	vCenter	4 Hosts
<input checked="" type="checkbox"/> Network boundaries (i)	NetworkCommodity/Oracle11g-Win-172.32	Turbonomic	12 Hosts
<input checked="" type="checkbox"/> Segmentation Commodity (i)	My Placement Policy	Turbonomic	16 Hosts
<input checked="" type="checkbox"/> LicenseAccessCommodity (i)	Linux	Turbonomic	70 Hosts

Click to see the potential hosts

POTENTIAL HOSTS: 12

By turning off the 4-Host constraints, you have 12 potential hosts for this VM. Click this label to see the resulting list of providers.

Related Entities

Search...

FILTER

- dc17-host-03.eng.vmturbo.com
vCenter | Large | ACTIVE
- hp-esx4.eng.vmturbo.com
vCenter | Medium | FAILOVER
- hp-esx7.eng.vmturbo.com
vCenter | Large | ACTIVE
- hp-esx8.eng.vmturbo.com
vCenter | Large | ACTIVE
- dc17-host-01.eng.vmturbo.com
vCenter | Large | ACTIVE

In this mode you can enable and disable different combinations of constraints. As you do, the **POTENTIAL PROVIDERS** label updates to show how many providers are available to your entity. To see the resulting list of providers, click the **POTENTIAL PROVIDERS** label.

List of Entities

Sort the list

44 Virtual Machines

Search...

Expand All | Collapse All

Active | All

By Virtual CPU | By Severity | By Name | By Utilization

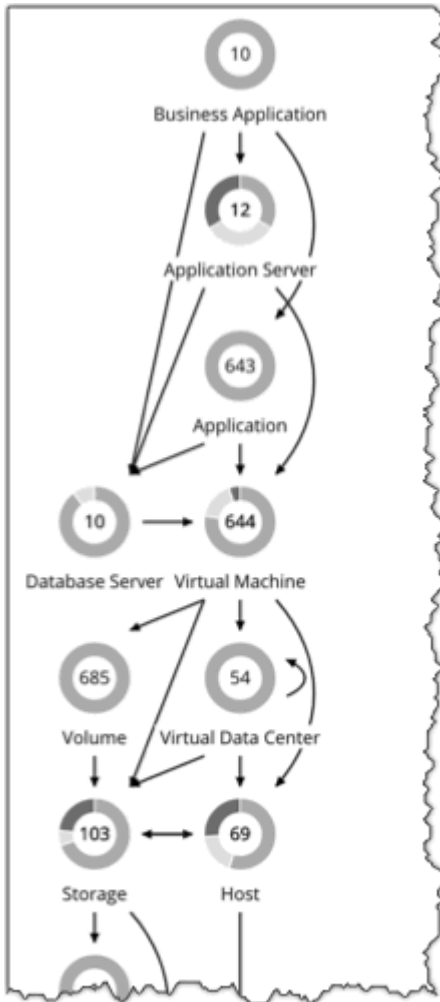
i-2-32-VM	52.06 GHz 5.00 % CPU Provisioned	39.99 GB 12.50 % Memory Provisioned	IDLE State
	2.68 TB 0.02 % Storage Amount	2.60 GHz 0.00 % Virtual CPU	5.00 GB 0.00 % Virtual Memory
iometer VM			
i-25-39-VM			
shai-test-4			

Expand/collapse details for an entry

The list of entities is a quick way to drill down to details about your environment, so you can see specifics about resource consumption or state. For example, you can see the amount of capacity that has been assigned to a VM that is currently idle.

This list always updates to reflect the focus you have selected in the Supply Chain Navigator. When you select an entity type in the supply chain, the entities list updates to show the entities of that type for your current scope. For example, select Host to see a list of hosts in the current scope. For more information, see [Navigating With the Supply Chain](#)

Navigating With the Supply Chain



After you have set the scope of your Turbonomic session, you can use the Supply Chain to change the focus of the main view, and see details about different types of entities within the current scope.

Drilling Down in a Scoped Session

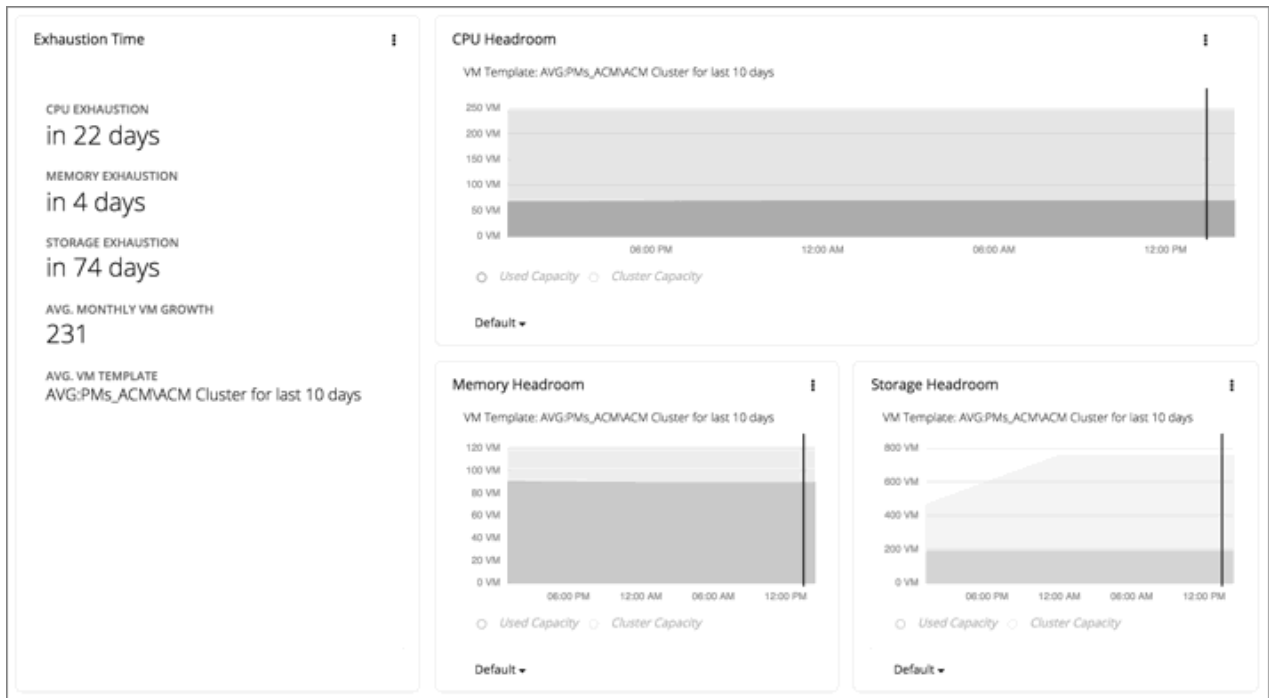
When you set a scope to your Turbonomic session, the **Home Page** shows information about your environment, including:

- Overview
Charts and lists to give you an overview of your environment for the current scope. This overview corresponds to all the entities in scope.
- Details - Charts that give you a more detailed look at your environment for the given scope
- Policies - Any policies that are defined for the entities in the current scope
- Entity Lists - Details about the entities in the current scope
- Pending Actions - Actions that are pending for any entities in the current scope

The Supply Chain shows the currently selected tier of entities. To change the focus of the scoped view, select different tiers in the Supply Chain. The Policies, Entities List, and Pending Actions tabs update to focus on the tier you selected. These tabs show information for all the entities of that type that are in the current scope. For example, if you click the Host tier, these tabs update to show information about the hosts in your current scope.

To zoom in on a specific entity, you can click its name in the Entities List. This sets the scope to that specific entity. To return to the previous scope, use the browser's **Back** button.

Viewing Cluster Headroom



Cluster headroom shows you how much extra capacity your clusters have to host workloads. When you set the scope to a cluster, the **Home Page** then includes charts that show headroom for that cluster, as well as time to exhaustion of the cluster resources.

To view cluster headroom:

1. Navigate to the Search page.
2. Choose the Clusters category.
3. Select the cluster you want to view.
4. When the **Home Page** displays, scroll down to show the headroom charts.

Make sure you have selected the Host tier in the supply chain navigator.

To calculate cluster capacity and headroom, Turbonomic runs nightly plans that take into account the conditions in your current environment. The plans use the Economic Scheduling Engine to identify the optimal workload distribution for your clusters. This can include moving your current VMs to other hosts within the given cluster, if such moves would result in a more desirable workload distribution. The result of the plan is a calculation of how many more VMs the cluster can support.

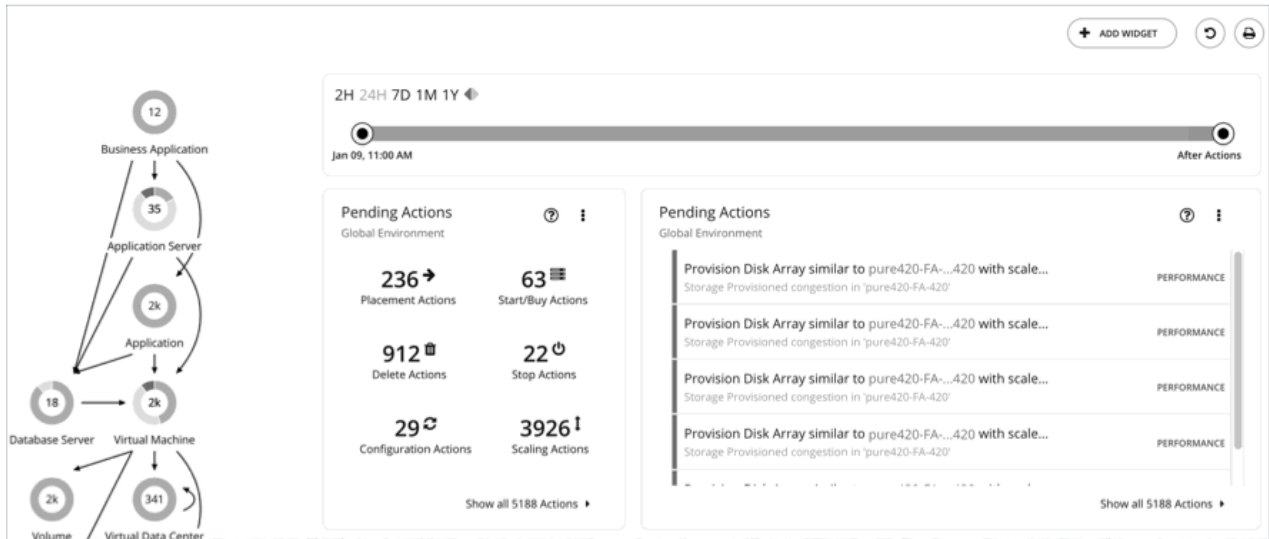
To calculate VM headroom, the plan simulates adding VMs to your cluster. The plan assumes a certain capacity for these VMs, based on a specific VM template. For this reason, the count of VMs given for the headroom is an approximation based on that VM template.

To specify the templates these plans use, you can configure the nightly plans for each cluster. For more information, see [Configuring Nightly Plans](#)

Turbonomic Actions

After you deploy your targets, Turbonomic starts to perform market analysis as part of its Application Resource Management process. This holistic analysis identifies problems in your environment and the

actions you can take to *resolve* and *avoid* these problems. Turbonomic then generates a set of actions for that particular analysis and displays it in the Pending Actions charts for you to investigate.



Turbonomic can generate the following actions:

Action	Description
Provision	Introduce new resource providers to update the environment's capacity. For example: <ul style="list-style-type: none"> Provisioning a host adds more compute capacity that is available to VMs. Provisioning a VM adds capacity to run applications.
Start	Start a suspended entity to add capacity to the environment.
Resize	Re-allocate resource capacity on an entity. For example, reduce vCPUs or vMem on a VM, or add volumes to a disk array.
Buy RI	For workloads that are good RI candidates, purchase RI capacity to move your environment toward the RI coverage that you desire.
Increase RI coverage	Increase RI coverage to reduce costs.
Reconfigure	<ul style="list-style-type: none"> Add necessary network access or reconfigure storage. For example, if a VM is configured to access a network that is not available on the host, the VM must reconfigure to use an available network. Reconfigure container pods.
Move	Change a consumer to use a different provider, such as moving a VM to a different host. Moving a VM to a different storage means relocating any file-based component that belongs to a virtual machine.

Action	Description
Suspend	<p>Stop and set resources aside without removing them from the environment.</p> <p>For example, you might suspend an underutilized host to save it for some time when you really need it, or suspend a virtual machine to save money.</p>
Delete	Remove storage (for example, datastores on disk arrays or unattached volumes).

Actions by Entity Type

Turbonomic generates actions based on how entity types use or provide resources, and what each entity type supports.

The following tables show the actions that each entity type supports:

Application Entity Types

Entity Type	Supported Actions
Business Application	<p>None</p> <p>Turbonomic does not recommend actions for a Business Application, but it does recommend actions for the underlying Application Components and infrastructure. The Pending Actions chart for a Business Application lists these actions, thus providing visibility into the risks that have a direct impact on the Business Application's performance.</p>
Business Transaction	<p>None</p> <p>Turbonomic does not recommend actions for a Business Transaction, but it does recommend actions for the underlying Application Components and infrastructure. The Pending Actions chart for a Business Transaction lists these actions, thus providing visibility into the risks that have a direct impact on the Business Transaction's performance.</p>
Service	<p><i>For non-Kubernetes Services:</i></p> <p>None</p> <p>Turbonomic does not recommend actions for non-Kubernetes Services, but it does recommend actions for the underlying Application Components and nodes. The Pending Actions chart for Services list these actions, thus providing visibility into the risks that have a direct impact on their performance.</p> <p><i>For Kubernetes Services:</i></p> <p>Provision or Suspend</p> <p>For horizontally scalable Kubernetes Services that collect performance metrics (or KPIs) for applications, Turbonomic can dynamically adjust the number of pod replicas that back those Services to help you meet SLOs (Service Level Objectives) for your applications.</p> <p>For details, see Actions for Kubernetes Services.</p>

Entity Type	Supported Actions
Application Component	<p>Resize</p> <p>Resize the following resources to maintain performance:</p> <ul style="list-style-type: none"> • Thread Pool • Connections • Heap <p>Turbonomic will recommend Heap resize actions if the Application Component sells Heap and Remaining Garbage Collection (GC) Capacity, and the underlying VM or container sells VMem.</p> <p>Note:</p> <p>The resources that Turbonomic can resize depend on the processes that it discovers from your Applications and Databases targets. In the <i>Target Configuration Guide</i>, refer to the topic for a specific target to see a list of resources that can be resized.</p>

Container Platform Entity Types

Entity Type	Supported Actions
Container	<p>Resize</p> <p>Resize containers to assure optimal utilization of resources. By default, containers resize consistently, which allows all replicas of the same container for the same workload type to resize any resource consistently.</p> <p>For details, see Container Actions.</p>
Container Spec	<p>None</p> <p>A Container Spec retains the historical utilization data of ephemeral containers. Turbonomic uses this data to make accurate container resize decisions, but does not recommend actions for the Container Spec itself.</p>
Namespace	<p>Resize Quota</p> <p>Turbonomic treats quotas defined in a namespace as constraints when making container resize decisions. If existing container actions would exceed the namespace quotas, Turbonomic recommends actions to resize up the affected namespace quota.</p> <p>Note that Turbonomic does not recommend actions to resize <i>down</i> a namespace quota. Such an action reduces the capacity that is already allocated to an application – The decision to resize down a namespace quota should include the application owner.</p>

Entity Type	Supported Actions
Workload Controller	<p>None</p> <p>A Workload Controller executes container actions. When you set the scope to a Workload Controller and view the actions list, the actions apply to containers. Turbonomic does not recommend actions for the Workload Controller itself.</p> <p>Note:</p> <p>Turbonomic uses namespace or organization/space quotas as constraints when making resize decisions. The Workload Controller aggregates container actions. If those container resizes exceed current namespace quotas, Turbonomic blocks execution of container resize actions until the namespace quotas are sufficient. For more information about namespace quotas, see Resource Quotas.</p>
Container Pod	<ul style="list-style-type: none"> • Move <p>Move a pod between nodes (VMs) to address performance issues or improve infrastructure efficiency. For example, if a particular node is congested for CPU, you can move pods to a node with sufficient capacity. If a node is underutilized and is a candidate for suspension, you must first move the pods before you can safely suspend the node.</p> <ul style="list-style-type: none"> • Provision/Suspend <p>For horizontally scalable Kubernetes Services that collect performance metrics (or KPIs) for applications, provision or suspend pods associated with those Services to maintain SLOs for your applications.</p> <p>When recommending node provision or suspend actions, Turbonomic will also recommend provisioning pods (based on demand from DaemonSets) or suspending the related pods.</p> <p>For details, see Container Pod Actions.</p>
Container Cluster	<p>None</p> <p>Turbonomic does not recommend actions for a Container Cluster. Instead, it recommends actions for the containers, pods, nodes (VMs), and volumes in the cluster. Turbonomic shows all of these actions when you scope to a Container Cluster and view the Pending Actions chart.</p>

Entity Type	Supported Actions
Kubernetes node (VM)	<p>A Kubernetes node (cloud or on-prem) is represented as a Virtual Machine entity in the supply chain.</p> <ul style="list-style-type: none"> Provision <p>Provision nodes to address workload congestion or meet application demand.</p> <p>When recommending node provision actions, Turbonomic also recommends pod provision actions that reflect the projected demand from required DaemonSet pods, and respects the maximum number of pods allowed for a node. This ensures that any application workload can be placed on the new node and stay within the desired range of vMem/vCPU usage, vMem/vCPU request, and number of consumers.</p> Suspend <p>Suspend nodes after you have consolidated pods or defragmented node resources to improve infrastructure efficiency.</p> <p>When recommending node suspension actions, Turbonomic also recommends suspending the DaemonSet pods that are no longer required to run the suspended nodes.</p> <p>For nodes in the public cloud, Turbonomic reports the cost savings or investments attached to these actions. For details, see Actions for Kubernetes Nodes (VMs).</p>

Cloud Infrastructure Entity Types

Entity Type	Supported Actions
Virtual Machine (Cloud)	<ul style="list-style-type: none"> • Scale Change the VM instance to use a different instance type or tier to optimize performance and costs. • Increase RI Coverage / Buy RI If you have a high percentage of on-demand VMs, you can reduce your monthly costs by increasing coverage. To increase coverage, you scale VMs to instance types that have existing capacity. If you need more RI capacity, then Turbonomic will recommend Buy RI actions. For details, see Cloud VM Actions. For cloud VMs used as Kubernetes nodes: <ul style="list-style-type: none"> • Provision Provision nodes to address workload congestion or meet application demand. When recommending node provision actions, Turbonomic also recommends pod provision actions that reflect the projected demand from required DaemonSet pods, and respects the maximum number of pods allowed for a node. This ensures that any application workload can be placed on the new node and stay within the desired range of vMem/vCPU usage, vMem/vCPU request, and number of consumers. • Suspend Suspend nodes after you have consolidated pods or defragmented node resources to improve infrastructure efficiency. When recommending node suspension actions, Turbonomic also recommends suspending the DaemonSet pods that are no longer required to run the suspended nodes. For nodes in the public cloud, Turbonomic reports the cost savings or investments attached to these actions. For details, see Actions for Kubernetes Nodes (VMs).
Database (Cloud)	<ul style="list-style-type: none"> • Scale <ul style="list-style-type: none"> • DTU Model Scale DTU and storage resources to optimize performance and costs. • vCore Model Scale vCPU, vMem, IOPS, throughput and storage resources to optimize performance and costs. For details, see Cloud Database Actions .
Database Server (Cloud)	<ul style="list-style-type: none"> • Scale Scale compute and storage resources to optimize performance and costs. For details, see Cloud Database Server Actions.

Entity Type	Supported Actions
Volume (Cloud)	<ul style="list-style-type: none"> • Scale Scale attached volumes to optimize performance and costs. • Delete Delete unattached volumes as a cost-saving measure. For details, see Cloud Volume Actions .
Zone	None Turbonomic does not recommend actions for a cloud zone.
Region	None Turbonomic does not recommend actions for a cloud region.

On-prem Infrastructure Entity Types

Entity Type	Supported Actions
Virtual Machine (On-prem)	<ul style="list-style-type: none"> • Resize <ul style="list-style-type: none"> – Resize resource capacity <p>Change the capacity of a resource that is allocated for the VM. For example, a resize action might recommend increasing the VMem available to a VM. Before recommending this action, Turbonomic verifies that the VM's cluster can adequately support the new size. If the cluster is highly utilized, Turbonomic will recommend a move action, taking into consideration the capacity of the new cluster and compliance with existing placement policies.</p> <p>For hypervisor targets, Turbonomic can resize vCPU by changing the VM's socket or cores per socket count. For details, see VCPU Scaling Controls.</p> – Resize resource reservation <p>Change the amount of a resource that is reserved for a VM. For example, a VM could have an excess amount of memory reserved. That can cause memory congestion on the host — A resize action might recommend reducing the amount reserved, freeing up that resource and reducing congestion</p> – Resize resource limit <p>Change the limit that is set on the VM for a resource. For example, a VM could have a memory limit set on it. If the VM is experiencing memory shortage, an action that decreases or removes the limit could improve performance on that VM.</p> • Move <p>Move a VM due to:</p> <ul style="list-style-type: none"> – High resource utilization on VM or host – Excess IOPS or latency in VStorage – Workload placement violation – Underutilized host (move VM before suspending host) • Move VM Storage (Volume) <p>Move a VM's volume due to excess utilization of the current datastore, or for more efficient utilization of datastores in the environment.</p> • Reconfigure <p>Change a VM's configuration to comply with a policy.</p> <p>For hypervisor targets, Turbonomic can reconfigure VMs that violate vCPU scaling policies. For details, see VCPU Scaling Controls.</p> • Reconfigure VM Storage <p>Reconfigure overutilized storage resources by adding VStorage capacity. For underutilized storage resources, remove VStorage capacity.</p> <p>For details, see On-prem VM Actions.</p> <p>For on-prem VMs used as Kubernetes nodes:</p> • Provision <p>Provision nodes to address workload congestion or meet application demand.</p> <p>When recommending node provision actions, Turbonomic also recommends pod provision actions that reflect the projected demand</p>

Entity Type	Supported Actions
Database Server (On-prem)	<p>Resize</p> <p>Resize the following resources:</p> <ul style="list-style-type: none"> • Connections • DBMem • Transaction Log <p>Resize actions based on the Transaction Log resource depend on support for vStorage in the underlying hypervisor technology. Because current versions of Hyper-V do not provide API support for vStorage, Turbonomic cannot support Transaction Log resize actions for database servers running on the Hyper-V platform.</p>
Volume (On-prem)	<p>Move</p> <p>Move a VM's volume due to excess utilization of the current datastore, or for more efficient utilization of datastores in the environment. To evaluate and execute actions, set the scope to the VM to which a volume is attached.</p>
Virtual Datacenter	<p>None</p> <p>Turbonomic does not recommend actions for a Virtual Datacenter. Instead, it recommends actions for the entities that provide resources to the Virtual Datacenter.</p>
Business User	<p>Move</p> <p>Move a Business User between desktop pools to address:</p> <ul style="list-style-type: none"> • Resource congestion on the image <p>When utilization is consistently near capacity for image resources, Turbonomic can recommend moving a Business User to a desktop pool that serves larger images.</p> <ul style="list-style-type: none"> • Resource congestion on the desktop pool <p>When utilization is consistently near capacity for the desktop pool, Turbonomic can recommend moving a Business User to a desktop pool that has more available resources.</p> <p>Note:</p> <p>To support moves, you must configure placement policies that merge <i>similarly configured</i> desktop pools. For details, see Desktop Pool Placement Policies.</p>
Desktop Pool	<p>None</p> <p>Turbonomic does not recommend actions for a desktop pool. It recommends actions for the Business Users running active sessions in the pool.</p>
View Pod	<p>None</p> <p>Turbonomic does not recommend actions for a view pod. Instead, it recommends actions for the Business Users that are running active sessions.</p>

Entity Type	Supported Actions
Host	<ul style="list-style-type: none"> • Start Start a suspended host when there is increased demand for physical resources. • Provision Provision a new host in the environment when there is increased demand for physical resources. Turbonomic can then move workloads to that host. • Suspend When physical resources are underutilized on a host, move existing workloads to other hosts and then suspend the host. • Reconfigure Turbonomic generates this action in response to changing demand for software licenses. For details, see License Policy. For details, see Host Actions.
Chassis	<p>None</p> <p>Turbonomic does not recommend actions for a chassis.</p>
Datacenter	<p>None</p> <p>Turbonomic does not recommend actions for a datacenter. Instead, it recommends actions for the entities running in the datacenter.</p>
Storage	<ul style="list-style-type: none"> • Move For high utilization of physical storage, move datastore to a different disk array (aggregate). • Provision For high utilization of storage resources, provision a new datastore. • Resize Increase or decrease the datastore capacity. • Start For high utilization of storage resources, start a suspended datastore. • Suspend For low utilization of storage resources, move served VMs to other datastores and suspend this one. • Delete Delete a datastore or volume that has been suspended for a period of time. For details, see Storage Actions.

Entity Type	Supported Actions
Logical Pool	<ul style="list-style-type: none"> • Resize • Provision • Move • Start • Suspend
Disk Array	<ul style="list-style-type: none"> • Provision For high utilization of the disk array's storage, provision a new disk array (recommendation, only). • Start For high utilization of disk array, start a suspended disk array (recommendation, only). • Suspend For low utilization of the disk array's storage, move VMs to other datastores and suspend volumes on the disk array (recommendation, only). • Move (Only for NetApp Cluster-Mode) For high utilization of Storage Controller resources, Turbonomic can move an aggregate to another storage controller. The storage controllers must be running. For high IOPS or latency, a move is always off of the current disk array. All the volumes on a given disk array show the same IOPS and Latency, so moving to a volume on the same array would not fix these issues. • Move VM For high utilization of Storage on a volume, Turbonomic can move a VM to another volume. The new volume can be on the current disk array, on some other disk array, or on any other datastore. For high IOPS or latency, a move is always off of the current disk array. All the volumes on a given disk array show the same IOPS and Latency, so moving to a volume on the same array would not fix these issues. • Move Datastore To balance utilization of disk array resources, Turbonomic can move a datastore to another array.
Storage Controller	<p>Provision</p> <p>For high utilization of the storage controller's CPU, provision a new storage controller, and then move disk arrays to it.</p>
IO Module	<p>None</p> <p>Turbonomic does not recommend actions for an IO Module.</p>
Switch	<p>Resize</p> <p>Resize PortChannel for a switch to increase bandwidth.</p>

Action Types

Turbonomic performs the following general types of actions:

- Placement — Place a consumer on a specific provider (place a VM on a Host)
- Scaling — Resize allocation of resources, based on profitability
 - Resize up, shown as a required investment
 - Resize down, shown as savings
- RI Optimization — Purchase RIs for specific workloads or move to RI tiers that are more appropriate for your applications' requirements
- Configuration — Correct a misconfiguration
- Start/Buy — Start a new instance to add capacity to the environment, shown as a required investment. For workloads that are good RI candidates, purchase RI capacity to move your environment toward the RI Coverage that you desire.
- Stop — Suspend an instance to increase efficient use of resources, shown as savings
- Delete — Remove storage (for example, datastores on disk arrays or unattached volumes)

Placement

Placement actions determine the best provider for a consumer. These include initial placement for a new entity, and move actions that change a consumer to use a different provider. For example, moving a VM assigns it to a different host. Moving a VM's storage means the VM will use a different datastore.

Placement Constraints

When making placement decisions, Turbonomic checks for placement constraints to limit the set of providers for a given consumer. It respects automatic placement constraints, including cluster boundaries and DRS rules. It also considers user-configured constraints defined in a placement policy to ensure compliance to specific business requirements.

You can run plans to see what happens if you turn off constraints, or disable or enable certain placement policies.

Effective CPU Capacity

CPU processor speed is not necessarily an effective indicator of CPU capacity. For example, processor architecture can make a slower CPU have a greater effective capacity. Newer models of machines can often have fewer cores or less clock speed, but still have a higher effective capacity.

When placing VMs on hosts in the on-prem environment, Turbonomic discovers the effective CPU capacity of your hosts. This increases the accuracy of placement calculations so that newer, more efficient hosts will show a greater effective capacity than less efficient hosts that might have larger or faster processors.

To discover the effective capacity, Turbonomic uses benchmark data from spec.org. This benchmark data maps to effective capacity settings that Turbonomic uses to make placement calculations.

You can see a catalog of these benchmark data and choose from listed processors when you edit Host templates. For more information, see [Selecting CPUs from the Catalog](#).

Shared-Nothing Migration Actions

If you have enabled both storage and VM moves, Turbonomic can perform shared-nothing migrations, which move the VM and the stored VM files simultaneously. For details, see [Shared-Nothing Migration](#).

Cross-vCenter vMotion

VMware vSphere 6.0 introduces functionality that enables migration of virtual machines between different vCenter Server instances. Turbonomic supports this capability through *Merge* placement policies

(see [Creating Placement Policies](#)). It considers cross-vCenter locations when calculating placement, and can recommend or execute moves to different vCenter servers.

Moves on the Public Cloud

On the public cloud you do not place workloads on physical hosts. In the Turbonomic Supply Chain, the Host nodes represent availability zones. Turbonomic can recommend moving a workload to a different zone, if such a move can reduce your cloud cost. These moves recognize constraints, such as availability of instances types and RIs in the given zones.

In AWS environments, a VM can use Elastic Block Stores (EBS) or Instance Storage. If the VM's root storage is EBS, then Turbonomic can recommend a VM move. However, because Instance Storage is ephemeral and a move would lose the stored data, Turbonomic does not recommend moving a VM that has Instance Storage as its root storage.

If a VM is running within a billing family, then Turbonomic only recommends moving that VM to other regions within that billing family.

In AWS environments that use RIs, Turbonomic recognizes Availability Zones that you have specified for your RI purchases. For move and resize actions, Turbonomic gives precedence to these RIs in the given zone. All else being equal for a given zone, if you have Zone RIs with reserved capacity and RIs that do not reserve capacity, Turbonomic will use the Zone RI first.

Scaling

Scaling actions update capacity in your environment. For vertical scaling, Turbonomic increases or decreases the capacity of resources on existing entities. For horizontal scaling it provisions new providers. For example, provisioning a host adds more compute capacity that is available to run VMs. Provisioning a VM adds capacity to run applications.

Turbonomic can provision the following:

- Containers
- VMs
- Hosts
- Storage
- Storage Controllers (only for planning scenarios)
- Disk Arrays

Under certain circumstances, Turbonomic can also recommend that you provision a virtual datacenter.

Storage Resize Actions

Any storage resize action impacts both the storage entities and the entities managed by the given hypervisor. However, not all hypervisors recognize changes to the storage capacity. After executing a storage resize, Turbonomic indicates that the resize action has succeeded but a hypervisor might not show the corresponding change in storage capacity. If this occurs, then you must refresh the hypervisor target so Turbonomic can discover the storage changes.

To avoid this situation, you can set the action mode to *Manual* or *Recommend* for storage resize actions. In that way, you can perform the resizes yourself, and then manually refresh your hypervisors.

Scaling on the Public Cloud

On the cloud, scaling actions change the VM to a different instance type. These can include:

- Changing a VM to an instance type with different capacity
- Changing on-demand to RI

For these actions, the action list shows the current cost for the source workload, and also the projected cost given the change. To show the current cost, Turbonomic uses the actual costs for that workload. However, to show the projected cost it uses an estimate based on average utilization for the VM, for the costs of the given tier.

Note that scaling to an RI can result in running the VM on a larger instance when the cost is lower. This might occur even though the VM does not need that capacity and there are other smaller tiers available.

In Azure environments, there are circumstances where a VM resize can be especially disruptive. In a given region, the infrastructure can be made up of different clusters that have different sets of underlying hardware. Further, some tiers that are available in the given region are only available on different clusters. If Turbonomic recommends resizing from a tier on one cluster, to a tier on another cluster, then the resize action can take longer to complete than usual.

In both Azure and AWS environments, Turbonomic conforms to specific instance requirements as it generates resize actions. For more information, see:

- [Azure Instance Requirements](#)
- [AWS Instance Requirements](#)

RI Optimization

Turbonomic can recommend purchasing RIs for specific workloads or moving to RI tiers that are more appropriate for your applications' requirements. See the following charts in the dashboard for relevant information:

- **RI Inventory** chart: Shows a list of RI workloads that Turbonomic discovered, listed by tiers
- **RI Utilization** chart: Shows how well you have utilized your RI inventory
- **RI Coverage** chart: Shows the capacity of your current VM workload compared to the capacity of workload that is covered by RIs

RI optimization actions are not executed by Turbonomic users. They reflect RI reassignment, which the cloud provider will take care of.

Configuration

These are reconfigure and resize actions. Reconfigure actions can add necessary network access, or reconfigure storage. Resize actions allocate more or less resource capacity on an entity, which can include adding or reducing VCPUs or VMem on a VM, adding or reducing capacity on a datastore, and adding or reducing volumes in a disk array.

Turbonomic can reconfigure the following:

- VMs
- Containers
- Storage
- Disk Arrays
- Virtual Datacenters

Start/Buy

Turbonomic can recommend that you start a suspended entity to add capacity to the environment. It can also recommend purchasing RI capacity to reduce costs for your current workload. For details, see [RI Purchases](#).

Stop

Stop actions suspend entities without removing them from the environment. Suspended capacity is still available to be brought back online, but is currently not available for use. Suspended resources are candidates for termination.

Turbonomic can suspend the following:

- Application Components
- Container Pods
- Disk Arrays
- Hosts
- Storage (on-prem)
- Virtual datacenter
- VMs

Delete

Delete actions affect storage. For example, Turbonomic might recommend that you delete wasted files to free up storage space, or delete unused storage in your cloud environment to reduce storage costs.

Wasted Storage in Azure Environments

In Azure environments, Turbonomic can identify unmanaged storage as unattached volumes, recommend that you remove this unused storage, and then show *estimated* savings after you remove this storage and no longer pay for it. The savings that Turbonomic shows are estimates based on the overall cost for that storage, since Azure does not provide specific values for the cost per volume or cost for the amount of storage that is in use for a given volume. If the estimated savings appear unusually high, then you should identify which storage the actions will remove, and review your billing to calculate the costs with more precision.

Action Categories

Turbonomic groups entries in the Actions List by different categories. These categories do not strictly define the severity of an issue, but they indicate the nature of the issue.

Performance Assurance

Ultimately, the reason to manage workloads in your environment is to assure performance and meet QoS goals. When Turbonomic detects conditions that directly put QoS at risk, it recommends associated actions in the Performance category. You can consider these critical conditions, and you should execute the recommended actions as soon as possible.

Actions	Risks/Opportunities
<ul style="list-style-type: none">• Provision a new VM, Host, Datastore• Increase or decrease the number of VCPUs• Provision a new container or container pod• Resize heap for an Application Component• Scale the resource capacity on an entity	<ul style="list-style-type: none">• <Resource> Congestion <p>High utilization of application resources. High utilization of resources on workload, host, or datastore.</p>

Efficiency Improvement

Efficient utilization of resources is an important part of running in the desired state. Running efficiently maximizes your investment and reduces cost. When Turbonomic discovers underutilized resources, it recommends actions to consolidate your operations. For example, it can recommend that you move certain VMs onto a different host. This can free a physical machine to be shut down.

Actions	Risks/Opportunities
<ul style="list-style-type: none"> • Move VM • Start or suspend VM • Buy RI • Scale down resource allocation 	<ul style="list-style-type: none"> • Overprovisioning <p>Excess resource capacity in a provider.</p>

Prevention

Turbonomic constantly monitors conditions, and works to keep your environment running in a desired state. As it finds issues that risk moving the environment out of this state, it recommends associated actions in the Prevention category. You should attend to these issues, and perform the associated actions. If you do not, the environment may drift away from the desired state, and the QoS for some services may be put at risk.

Actions	Risks/Opportunities
<ul style="list-style-type: none"> • Resize vCPU and vMem • Move VM or storage • Start VM or host 	<ul style="list-style-type: none"> • <Resource> Congestion <p>High resource utilization on the named VM, host, or datastore. For example, CPU congestion or memory congestion can occur on a VM or physical machine, or an IOPS bottleneck can occur on a datastore.</p> <ul style="list-style-type: none"> • Workload Balancing <p>Excess workload on a given physical machine that can be addressed by moving a VM to another host.</p>

Compliance

A virtual environment can include policies that limit workload placement or availability of resources. It's possible that the environment configuration violates these defined policies. It's also possible that an entity is mis-configured in some way. For example, a VM might be configured to access a network that is not available in its current host cluster. In such cases, Turbonomic identifies the violation and recommends actions that bring the entity back into compliance.

Actions	Risks/Opportunities
<ul style="list-style-type: none"> • Move VM • Move container • Provision VM, Host, Datastore 	<ul style="list-style-type: none"> • Misconfiguration <p>Container configuration is in violation of a policy.</p> <ul style="list-style-type: none"> • Placement Violation <p>The placement of a VM is in violation of a Turbonomic policy or an imported Placement Policy.</p> <ul style="list-style-type: none"> • Misconfiguration <p>The configuration violates discovered requirements. For example, a VM is configured to access a network that is not available from the current cluster.</p>

Action Modes

Action modes specify the degree of automation for the generated actions. For example, in some environments you might not want to automate resize down of VMs because that is a disruptive action. You would use action modes in a policy to set that business rule.

Turbonomic supports the following action modes:

- **Recommend** — Recommend the action so a user can execute it via the given hypervisor or by other means
- **Manual** — Recommend the action, and provide the option to execute that action through the Turbonomic user interface
- **Automatic** — Execute the action automatically

For automated resize or move actions on the same entity, Turbonomic waits five minutes between each action to avoid failures associated with trying to execute all actions at once. Any action awaiting execution stays in queue. For example, if a VM has both vCPU and vMem resize actions, Turbonomic could resize vCPU first. After this resize completes, it waits five minutes before resizing vMem.

The Pending Actions charts only count actions in *Recommend* or *Manual* mode.

Automated actions appear in the following charts:

- **All Actions** chart on the **Home Page** and the On-prem Executive Dashboard
- **Accepted Actions** chart on the **Home Page**

Setting Action Modes

To set action modes for specific entities, you can edit the Turbonomic automation policies. This is how you specify the default action modes, or set special action modes for a given group or cluster. For more information, see [Automation Policies](#).

Action Mode Overrides

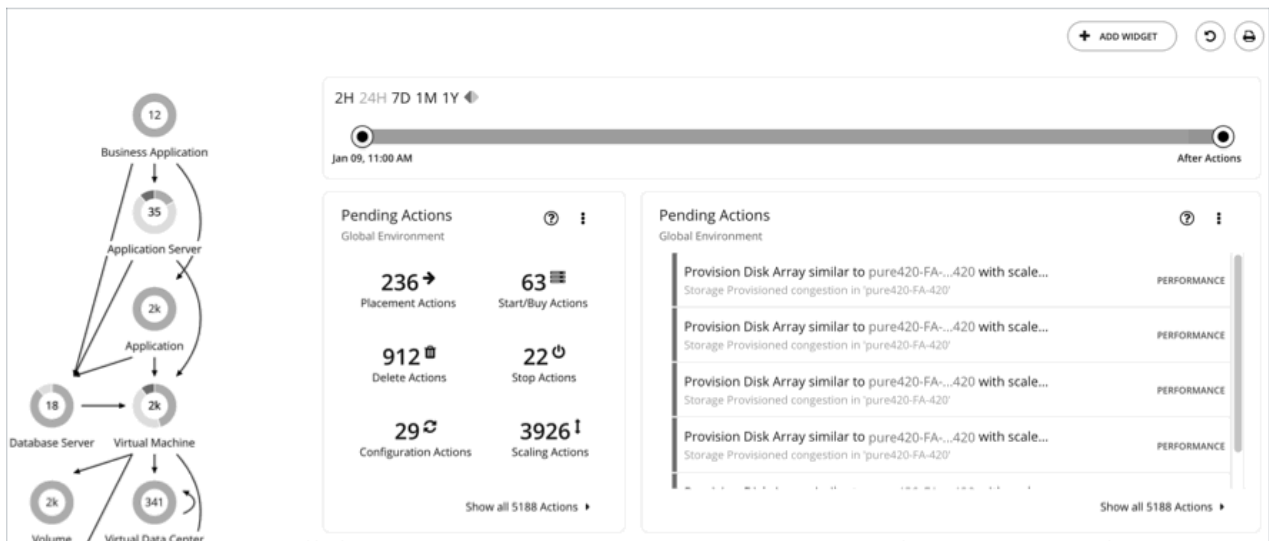
Under some conditions, Turbonomic changes the action mode of an action from *Manual* to *Recommend*.

Turbonomic makes this change as a safeguard against executing actions that the underlying infrastructure cannot support. For example, assume you have VM move actions set to *Manual*. Then assume Turbonomic analysis wants to move a VM onto a host that is already utilized fully. In this case, there would be other actions to move workloads *off* of the given host to make room for this new VM. However, because moves are *Manual*, the host might not be properly cleared off yet. In that case, Turbonomic changes actions to move workloads *to* the host from *Manual* to *Recommend*.

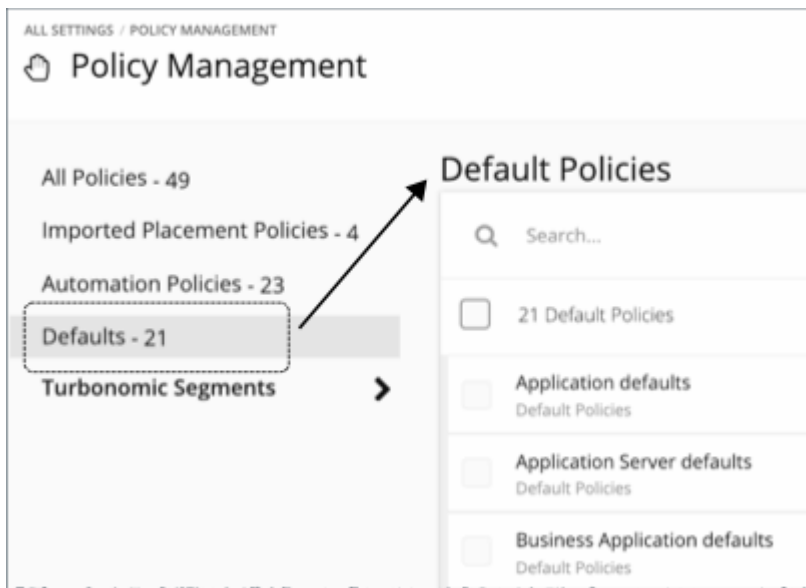
For cloud environments, some instances require workloads to be configured in specific ways before they can move to those instance types. If Turbonomic recommends moving a workload that is not suitably configured onto one of these instances, then it changes the action mode from *Manual* to *Recommend*, and then describes the reason.

Working With the Generated Actions

When you start using Turbonomic, all the actions that the product generates appear as pending. You can view them in the Pending Actions charts and then decide whether to execute and/or automate them. You can also disable them.



Turbonomic will never execute actions automatically, unless you tell it to. If you examine the default policies that ship with the product, you will notice that these policies do not enable automation on any action. Turbonomic gives you full control over all automation decisions.



When you first see the pending actions, you execute many of them to see immediate improvements in performance and utilization. Over time, you develop and fine-tune your action-handling process to meet productivity goals and respond to changing business needs. This process could lead to the following key decisions:

- Disabling actions that should never execute, such as those that violate business rules
Turbonomic will not consider recommending disabled actions when it performs its analysis.
- Allowing certain actions to execute automatically, such as those that assure QoS on mission-critical resources

Automation simplifies your task, while ensuring that workloads continue to have adequate resources to perform optimally. As such, it is important that you set the goal of automating as many actions as possible. This requires evaluating which actions are safe to automate, and on which entities.

- Continuing to let Turbonomic post certain actions so you can execute them on a case-by-case basis

For example, certain actions might require the approval of specific individuals. In this case, you would want Turbonomic to post those actions for review and only execute the actions that receive an approval.

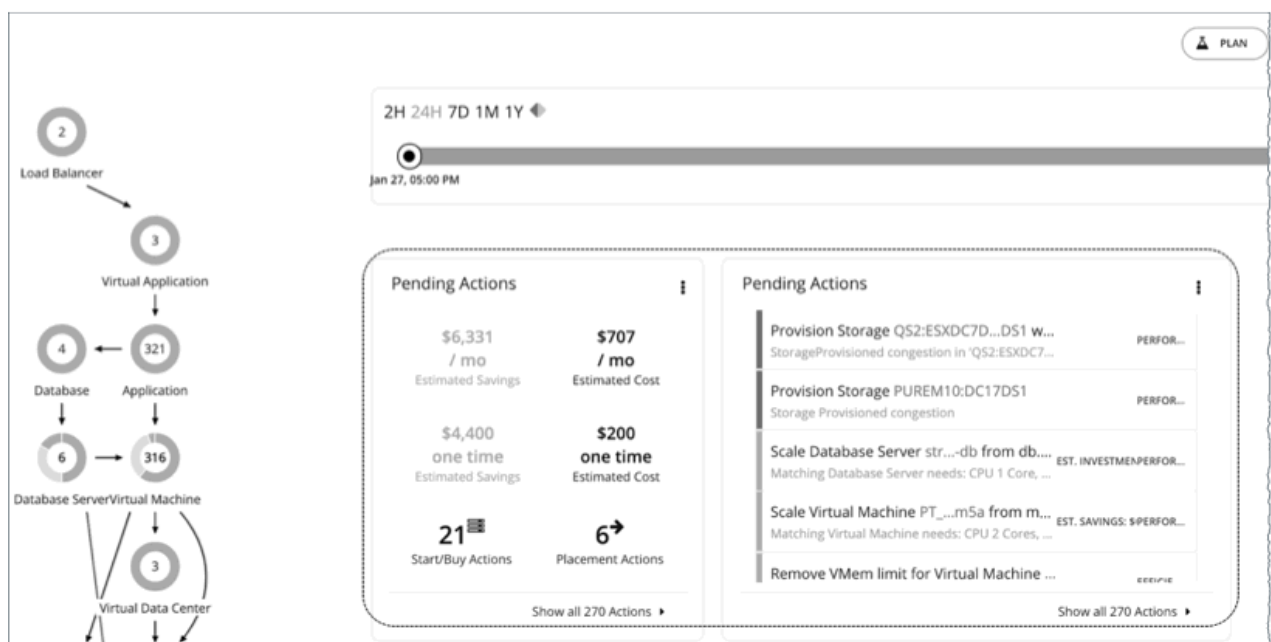
These are the actions that you would look for in the Pending Actions charts. They no longer show after you execute them, if you disable or automate them, or if the environment changes in the next market analysis such that the actions are no longer needed.

What You Can Do:

- View and execute pending actions: See [Pending Actions](#).
- See the different display views for the pending actions charts: See [Pending Actions Charts](#).
- Scope pending actions in the **Home Page**: See [Pending Actions Scope](#).
- See a running history of generated and executed actions: See [Actions Charts](#).
- Review the default policies that drive the actions the product generates.
- Create and run plans to simulate different conditions, and see what actions will keep things healthy under those conditions: See [Plan Management](#).

Pending Actions

Turbonomic treats all the non-automated actions that it generates as pending and shows them in the Pending Actions charts.



To get the best results from Turbonomic, execute these actions promptly and consider automating as many of them as possible. You can execute these actions from the user interface or outside Turbonomic. To automate these actions, create an [automation policy](#) or change the action mode to *Automatic* in the [default policies](#).

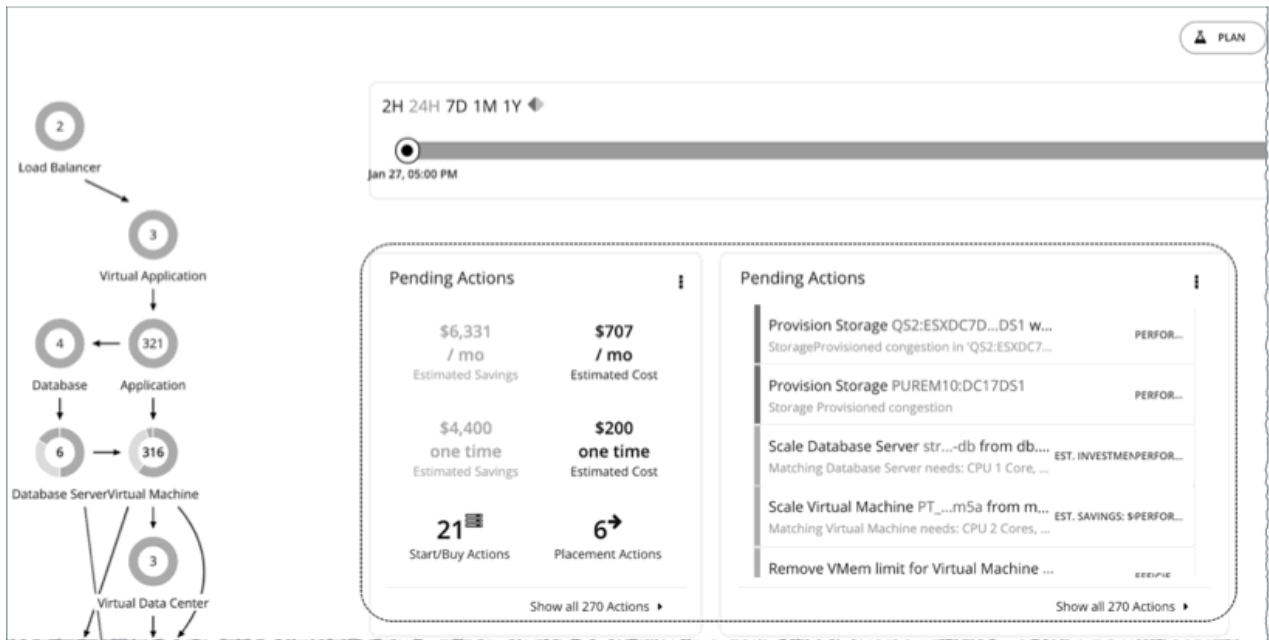
Turbonomic can execute up to five actions at a time, and queues any new incoming actions for later execution.

Default Pending Actions Charts

Each time you log in to the user interface, Turbonomic immediately shows the Pending Actions charts on the **Home Page**'s **HYBRID** view. These charts provide a summary of the actions that require your attention, and entry points to the [Pending Actions List](#).

Note:

You can also add these charts to any of your [dashboards](#).

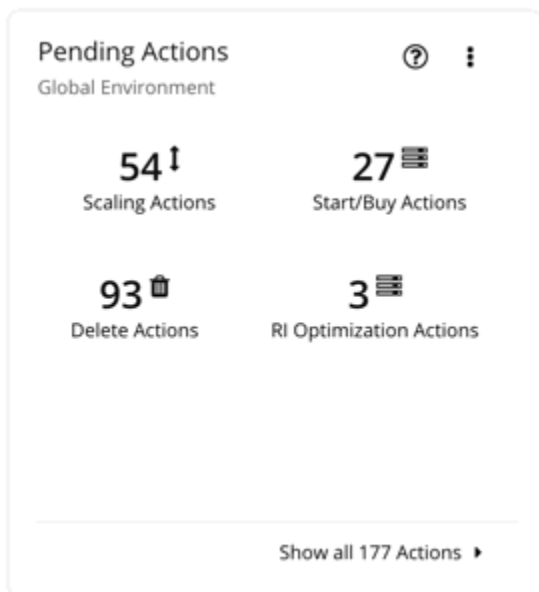


By default, a text chart and a list chart display in the **Home Page**, with the scope set to *Global Environment*.

You can change the chart type by clicking the icon on the upper-right corner of the chart. For details about the available chart types, see [Pending Actions Charts](#).

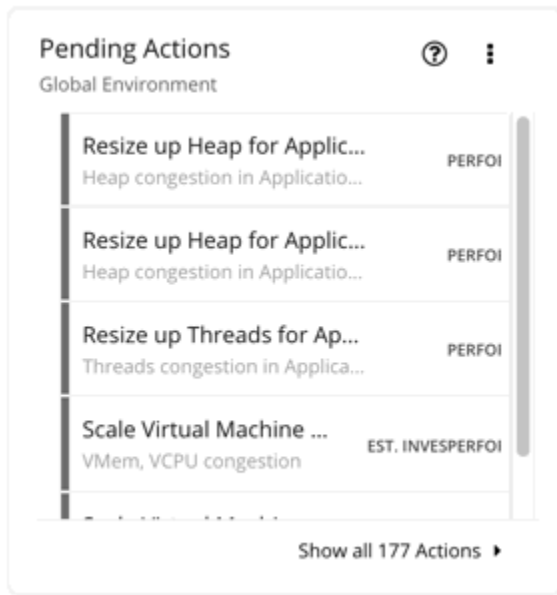
Pending Actions - Text Chart

The **text chart** shows the estimated costs or savings associated with the pending actions, and the number of actions for each [action type](#).



Pending Actions - List Chart

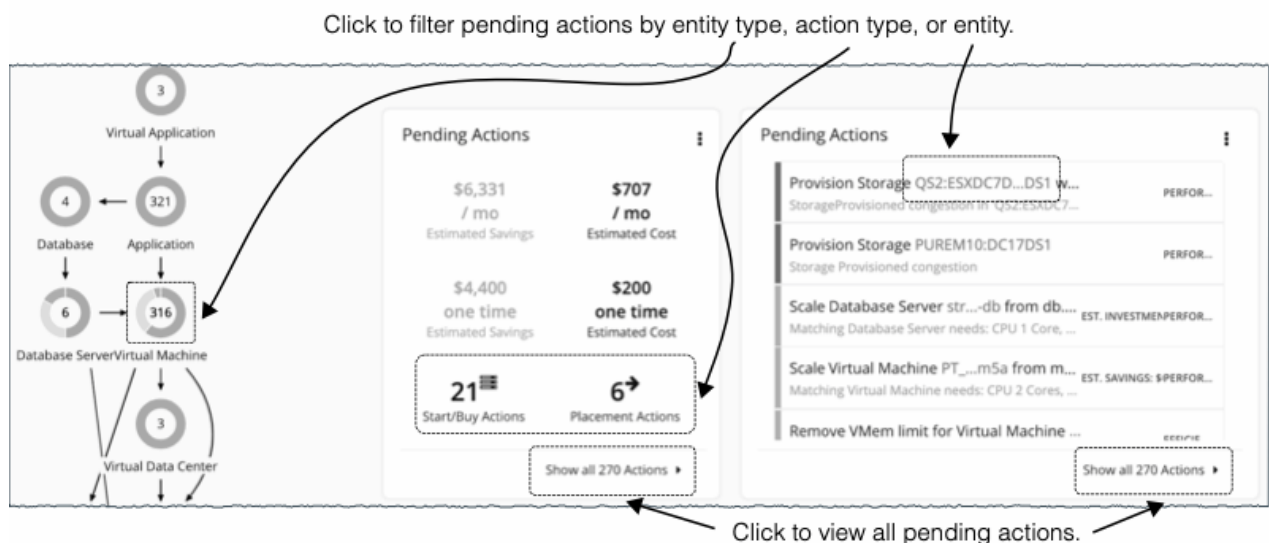
The **list chart** shows a partial list of pending actions, ordered by the severity of the associated problems.



Pending Actions Scope

To perform Application Resource Management, Turbonomic identifies actions you can take to *avoid* problems before they occur. You can perform these actions manually, direct Turbonomic to perform the actions on command, or direct Turbonomic to perform actions automatically as they arise.

There are several ways to scope pending actions in the **Home Page**.



To view all pending actions, click **Show all Actions** in the Pending Actions chart.

Click one of the following to narrow the scope of pending actions:

- An entity type in the supply chain.

Turbonomic generates actions based on how entity types use or provide resources, and what each entity type supports. For details on the actions that each entity type supports, see [Actions by Entity Type](#).

Only entity types with risks (critical, major, or minor) have pending actions. Hover on the entity type to see a breakdown of risks.

- An action type in the text chart
- An entity name in the list chart

Note:

If you are in the **ON-PREM** or **CLOUD** view, the text chart displays by default. Switch to the list chart to see the entity names.

If you clicked **Show all Actions** or an action type, the [Pending Actions List](#) displays immediately.

If you clicked an entity type or an entity name, an Overview page displays first. In that page, click the **Actions** tab to view the Pending Actions List.

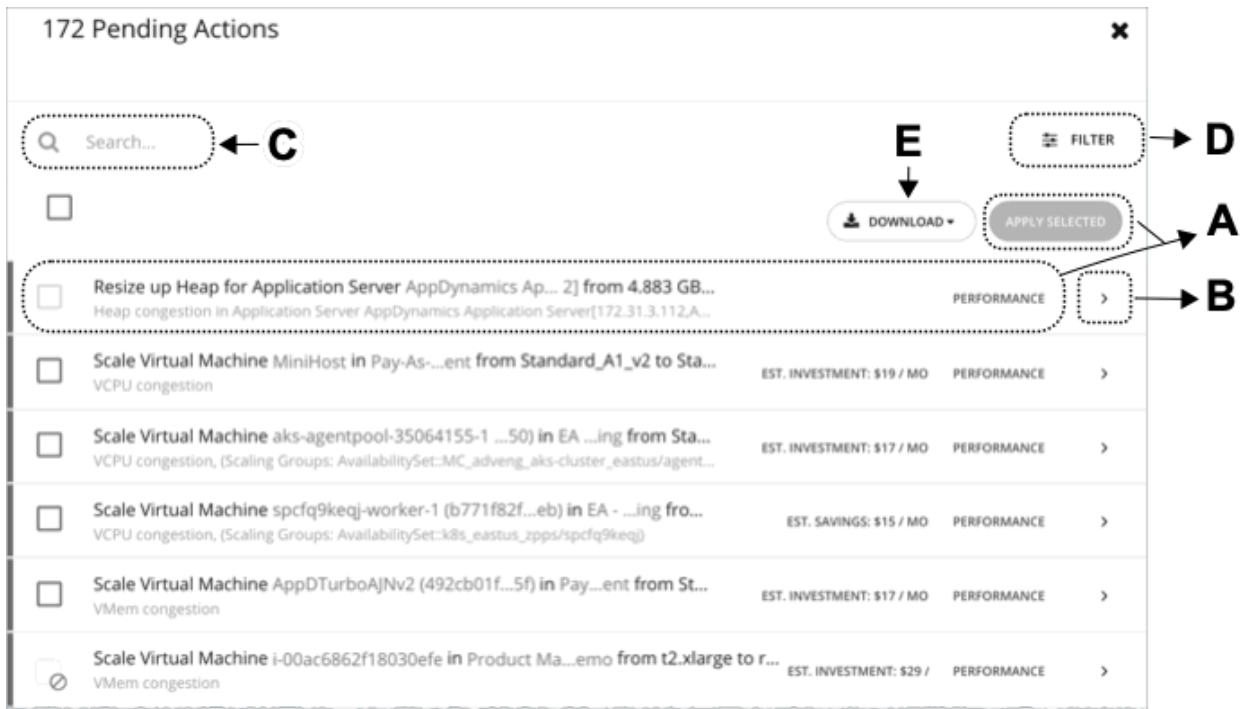
OVERVIEW DETAILS POLICIES LIST OF VIRTUAL MACHINES (312) ACTIONS (138)				
<input type="text" value="Search..."/>		<input type="button" value="FILTER"/>		
<input type="checkbox"/>		<input type="button" value="APPLY SELECTED"/>		
<input checked="" type="checkbox"/>	Scale Virtual Machine PT_m5_Resize_to_m5a from m5.large to i3.large Matching Virtual Machine needs: CPU 2 Cores, Virtual Memory 6.04 GB	EST. SAVINGS: \$0.107 / HR	PERFORMANCE	<input type="button" value=">"/>
<input checked="" type="checkbox"/>	Remove VMem limit for Virtual Machine AJ_Test to maximize efficiency VMem congestion in Virtual Machine 'AJ_Test'		EFFICIENCY	<input type="button" value=">"/>
<input type="checkbox"/>	Scale Virtual Machine PT_ARM from a1.large to a1.xlarge Matching Virtual Machine needs: CPU 3 Cores, Virtual Memory 1.42 GB	EST. INVESTMENT: \$0.051 / HR	PERFORMANCE	<input type="button" value=">"/>
<input type="checkbox"/>	Move Volume vol-01612aa64763cd9b7 of Virtual Machine arsen-turbo.... Improve overall performance	EST. INVESTMENT: \$0.045 / HR	PREVENTION	<input type="button" value=">"/>

The Pending Actions List includes additional features to narrow the scope further. You can search for specific actions using meaningful keywords or use filters. For details, see [Pending Actions List](#).

Pending Actions List

The Pending Actions List includes all the actions that Turbonomic currently recommends for the given scope (for details, see [Pending Actions Scope](#)).

You can select actions to execute, and you can expand action items to see more details.



A. Actions List

Each row in the actions list shows:

- The specific action that Turbonomic recommends.
- If applicable, the estimated investment needed to successfully execute the action or the resulting savings after performing the action
- The [action category](#).

By default, actions display by the severity of the associated problems, indicated by the thin colored line before the checkbox. Use the Filter functionality to change the order by other categories.

Select one or several actions to execute and click **Apply Selected**.

If you see an action with:

- A grayed-out checkbox (☐)

The action is recommended-only.

Possible reasons:

- The action mode is *Recommend* or the underlying technology for the entity does not support automation. This means you have to perform the action outside Turbonomic.
The Action Details page indicates that the action is blocked by a policy.
- An action that is otherwise executable cannot be executed currently due to prerequisite actions.

For example, in order to suspend Host A, VM_01 in the host must first move to Host B. However, Host B only has capacity for one VM and is currently hosting VM_02. In this case, Host A suspension is blocked by two prerequisite actions – VM_02 moving to another host and VM_01 moving to Host B.

The Action Details page for the main action (Host A suspension in the example) indicates that there are actions on the target or destination that need to be executed first.

When all the prerequisite actions have been executed, the main action becomes executable.

- A grayed-out checkbox and a prohibition symbol (☐)

You need to perform some prerequisite steps outside Turbonomic before you can execute the action. Hover on the checkbox to see the prerequisite steps.

Scale VM ComplianceMove2 in Development from t2.micro to t3.nano EST. SAVINGS: \$0.00 EFFICIENCY >

Matching Virtual Machine needs: CPU 1 Core, Virtual Memory not monitored

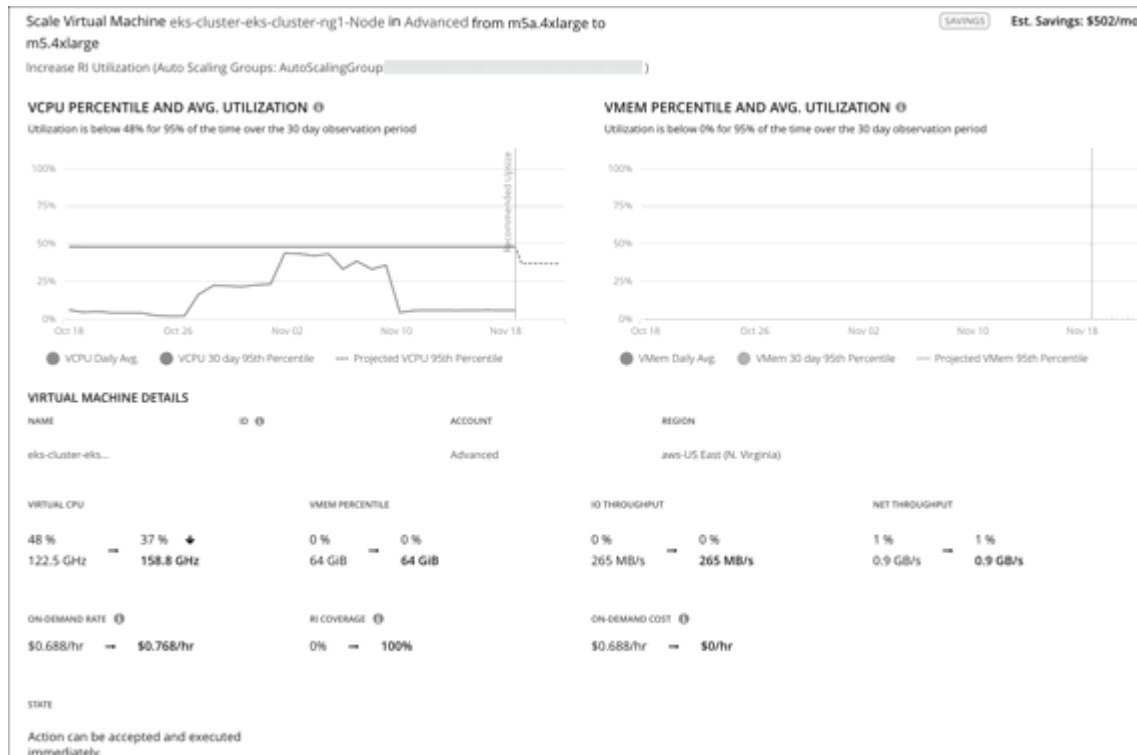
To execute this action, enable NVMe for ComplianceMove2, and change instance type in the AWS Console

Scale11g-Win-172.32 fro... EST. SAVINGS: \$200 EFFICIENCY >

11g-Win-172.32

B. Action Details

Click the arrow icon to expand the entry and view action details.



Action details include:

- A description of the recommended action, such as **Scale Virtual Machine...**

Note:

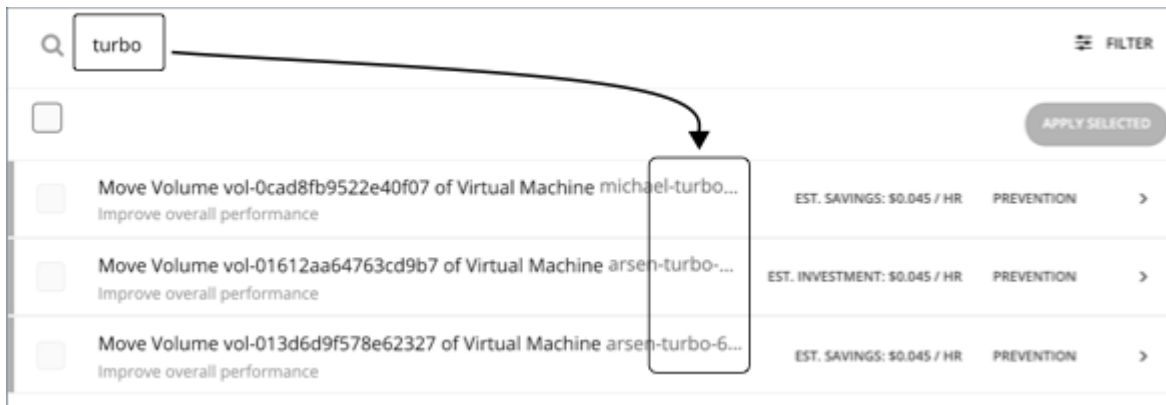
The action item gives the names of the affected entities. You can click on these entity names to drill down and set the **Home Page** scope to that specific entity. To return after drilling down to an entity in the action details, use the browser's **Back** button.

- Immediately below the description, a summary of requirements, risks, opportunities, or reasons for the recommended action
- The impact of executing the action.

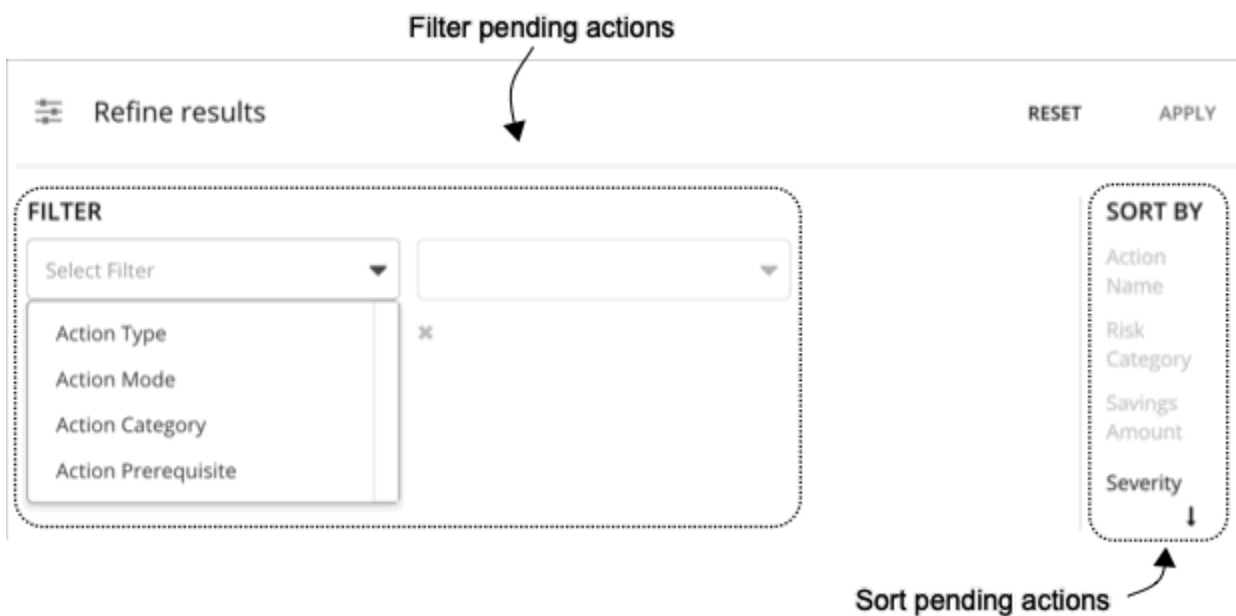
For more information, see [Action Details](#).

C. Search

For a long list of pending actions, use search to narrow the results.



D. Filter and Sort



When you click **Filter**, you can:

- Filter the list by action type, action mode, action category, action prerequisite, or any combination of these items.
- Sort the actions in ascending or descending order by severity, name of the action target, risk category, or savings amount.

Turbonomic determines action severity by the amount of improvement the affected entities will gain by executing the action. Action severities are:

- Minor — Issues that affect cost or workload distribution, but not impact the QoS your users will experience
- Major — Issues that can affect QoS and should be addressed
- Critical — Issues that affect the QoS that your environment can deliver, and you are strongly advised to address them

For example:

- To see only the actions that you can execute through the Turbonomic user interface, filter the list by action mode and select **Manually executable**.

FILTER

Action Mode ▼

equals ▼

Manually executable ▼ ×

ADD CRITERIA

- To see only resize actions that are manually executable and that give efficiency improvements, set the filter as follows:

FILTER

Action Type ▼

equals ▼

Scaling ▼ ×

Action Mode ▼

equals ▼

Manually executable ▼ ×

Action Category ▼

equals ▼

Efficiency Improvement ▼ ×

ADD CRITERIA

E. Download

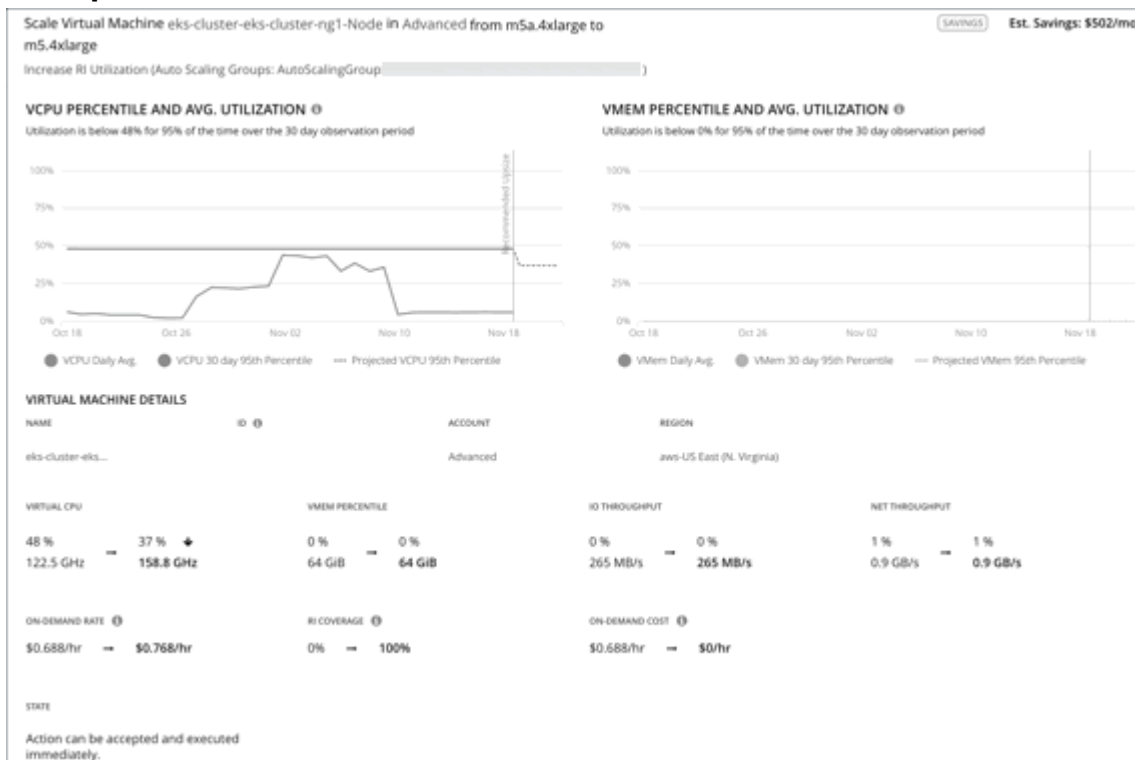
Download the pending actions list as a CSV file.

Action Details

Each action in the Pending Actions list comes with a description and additional details to help you understand why Turbonomic recommends it and what you would gain if you execute it.

At first glance, some individual actions might appear trivial and it is instinctively convenient to ignore them. It is important to keep in mind that executing a single action can impact other workloads in a meaningful way, helping move these other workloads closer to their desired state.

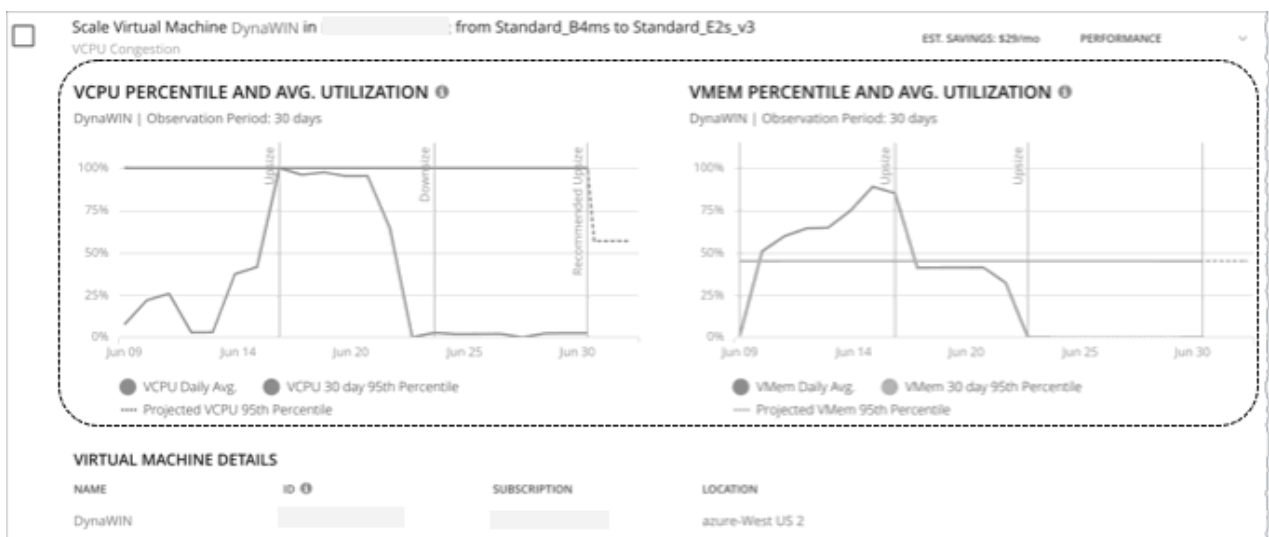
Example



In the image shown above, the action details indicate that scaling the virtual machine to a different instance type impacts RI coverage in a meaningful way. By increasing RI coverage from 0% to 100%, the projected hourly on-demand cost drops to \$0, bringing estimated savings of \$502 per month.

Utilization Charts

Turbonomic uses percentile calculations to measure resource utilization more accurately, and drive actions that improve overall utilization and reduce costs for cloud workloads. When you examine the details for an entity or pending action, you will see charts that highlight resource *utilization percentiles* for a given observation period, and the projected percentiles after you execute the action.



The charts also plot *daily average utilization* for your reference. If you have previously executed scaling actions on the entity, you can see the resulting improvements in daily average utilization. Put together, these charts allow you to easily recognize utilization trends that drive Turbonomic's recommendations.

Notes:

- You can set constraints in policies to refine the percentile calculations.
- After you execute an action, it might take some time for the charts to reflect the resulting improvements.

Entities with Utilization Charts

Utilization charts display for actions on the following entity types:

Entity Type	Monitored Resources	Notes
Virtual Machine	<ul style="list-style-type: none">• vCPU• vMem	<p>For on-prem VMs, you will see either a VCPU or VMem chart, depending on the commodity that needs to scale. For cloud VMs and VMs in Migrate to Cloud plans, both charts display.</p> <p>These charts also appear when you scope to a given VM (on-prem or cloud) and view the Details page. They also appear in Migrate to Cloud plan results.</p>
Database (cloud)	<ul style="list-style-type: none">• DTU Pricing Model<ul style="list-style-type: none">– DTU– Storage• vCore Pricing Model<ul style="list-style-type: none">– vCPU– vMem– IOPS– Throughput– Storage	See Cloud Database Actions .
Database Server (cloud)	<ul style="list-style-type: none">• vCPU• vMem and DB Cache Hit Rate• IOPS	See Cloud Database Server Actions .
Volume (cloud)	<ul style="list-style-type: none">• IOPS• Throughput	<p>These charts also appear when you scope to a given volume and view the Details page.</p> <p>See Cloud Volume Actions.</p>
Workload Controller	<ul style="list-style-type: none">• vCPU limits and requests• vMem limits and requests	See Container Actions .

Actions Tips and Best Practices

To get the best results from Turbonomic's Application Resource Management, you should set as many actions as possible to *Automated*. If you want to approve any changes, set the actions to *Manual*.

At first glance, individual actions might appear trivial and it is instinctively convenient to ignore them. It is important to keep in mind that executing a single action can impact other workloads in a meaningful way, helping move these other workloads closer to their desired state. However, if you find that a recommended action is not acceptable (for example, if it violates existing business rules), you can set up a policy with your preferred action.

In some cases, actions can introduce disruptions that you want to avoid at all costs. For example, during critical hours, Turbonomic might execute a resize action on a mission critical resource, which then requires that resource to restart. It is important to anticipate these disruptions and plan accordingly. For example, you can create a group for all critical resources, scope the group in an automation policy, set the action mode to *Automatic*, and then set the schedule to off-peak hours or weekends. For details on setting schedules, see [Setting Policy Schedules](#).

Resize Actions

Allow VMs that have hot-add enabled to automatically resize up.

Use Tuned Scaling to automatically resize VM and storage resources when the resize amount falls within an acceptable range, and for Turbonomic to notify you when the amount falls outside the range so you can take the most appropriate action. For details, see [Tuned Scaling for On-prem VMs](#).

After executing a storage resize, Turbonomic indicates that the resize action has succeeded but the hypervisor might not show the corresponding change in storage capacity. If this occurs, perform a manual refresh of the hypervisor so it can discover the storage changes.

Move Actions

Turbonomic recommends automating host and storage migration.

Use placement constraints if you have placement requirements for specific workloads in your environment (for example, all production virtual machines moving only to specific clusters). Turbonomic can automatically import placement policies when you add a target, or you can create new placement policies. For more information, see [Placement Policies](#).

Working With Policies

Policies set business rules to control how Turbonomic analyzes resource allocation, how it displays resource status, and how it recommends or executes actions. Turbonomic includes two fundamental types of policies:

- Placement Policies

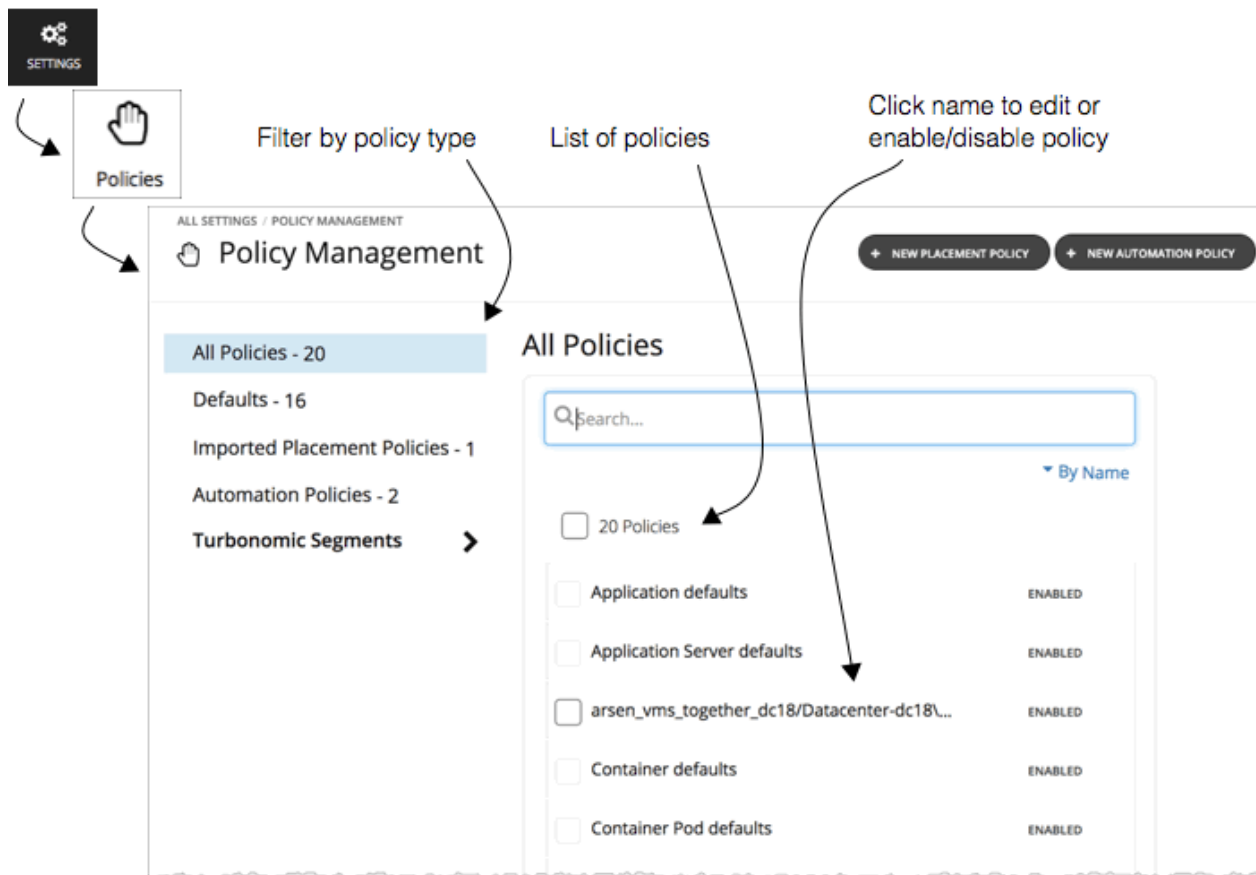
To modify workload placement decisions, Turbonomic divides its market into segments that constrain the valid placement of workloads. Turbonomic discovers placement rules that are defined by the targets in your environment, and you can create your own segments.

- Automation Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

The Policy Management page shows all the currently defined policies. From this page you can:

- Create new policies.
- Delete a user-created policy.
- Edit a default or user-created policy.
- Enable or disable discovered placement policies. For a Turbonomic segment (a placement policy that was created in Turbonomic), you can edit the policy definition as well as enable/disable it.



To see the policies that are applied to a scope, go to the Search page and set the Turbonomic session to that scope. Then show the Policy view. For more information, see [Scope Policies](#).

Placement Policies

For planning and optimization, Turbonomic recommends actions to place workloads such as applications, or VMs on their providers (hosts, datastores, disk arrays, networks, etc.). Turbonomic can recommend these actions, or execute them automatically.

When calculating workload placement, Turbonomic respects cluster boundaries, networks, and provisioned data stores. In addition, the configuration of your environment can specify logical boundaries, and within Turbonomic you can create even more boundaries. These boundaries impose segments on the market that Turbonomic uses to model your application infrastructure.

In finance, a market segment divides the market according to the criteria different groups of people use when they buy or sell goods and services. Likewise in the Turbonomic market, a workload placement segment uses criteria to focus the buying and selling of resources within specific groups of entities. This gives you finer control over how Turbonomic calculates moves. When managing segments you can:

- Review the placement policies that Turbonomic has discovered. These are policies that have been defined in your environment, outside of Turbonomic. See [Importing Workload Placement Policies](#).
- Create placement segments that restrict workload placement according to specific rules. See [Creating Placement Policies](#).

Note:

You can enable or disable any imported policy or created workload placement segment to affect placement calculations in the real-time environment or in plans.

Importing Workload Placement Policies

The hypervisors that you set as targets can include placement policies of their own. Turbonomic imports these placement policies, and considers them to be constraints on placement. You cannot disable these imported policies for real-time analysis, but you can disable them for plans.

Turbonomic imports:

- vCenter Server DRS Rules

See [Other Information Imported from vCenter](#)

- Virtual Machine Manager Availability Sets

See [Virtual Machine Manager](#)

- Flexera One License Specifications

See [Flexera](#)

Note:

In vCenter environments, Turbonomic does not import DRS rules if DRS is disabled on the hypervisor. Further, if Turbonomic did import an enabled DRS rule, and somebody subsequently disables that DRS rule, then Turbonomic will discover that the rule was disabled and will remove the imported placement policy.

Creating Placement Policies

Placement Policies set up constraints to affect how Turbonomic calculates the placement of workloads in your environment. In this way, you can direct Turbonomic to recommend actions that satisfy business rules for your enterprise.

Turbonomic discovers Placement policies that have been defined in your environment, and you can also create Placement policies through the Turbonomic user interface. Note that you can enable or disable any Placement policy, both for real-time analysis and for planning scenarios.

Turbonomic supports the following placement policies:

- **Place** — Determine which entities use specific providers

For example, the VMs in a consumer group can only run on a host that is in the provider group. You can limit the number of consumers that can run on a single provider — for hosts in the provider group, only 2 instances of VMs in the consumer group can run on the same host. Or no more than the specified number of VMs can use the same storage device.

- **Don't Place** — Consumers must never run on specific providers

For example, the VMs in a consumer group can never run on a host that is in the provider group. You can use such a segment to reserve specialized hardware for certain workloads.

- **Merge** — Merge clusters into a single provider group

For example, you can merge three host clusters in a single provider group. This enables Turbonomic to move workload from a host in one of the clusters to a host in any of the merged clusters to increase efficiency in your environment.

- **License** — Set up hosts to provide licenses for VMs

For VMs that require paid licenses, you can create placement policies that set up certain hosts to be the VMs' preferred license providers. Turbonomic can then recommend consolidating VMs or reconfiguring hosts in response to changing demand for licenses.

1. Navigate to the Settings Page.



Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

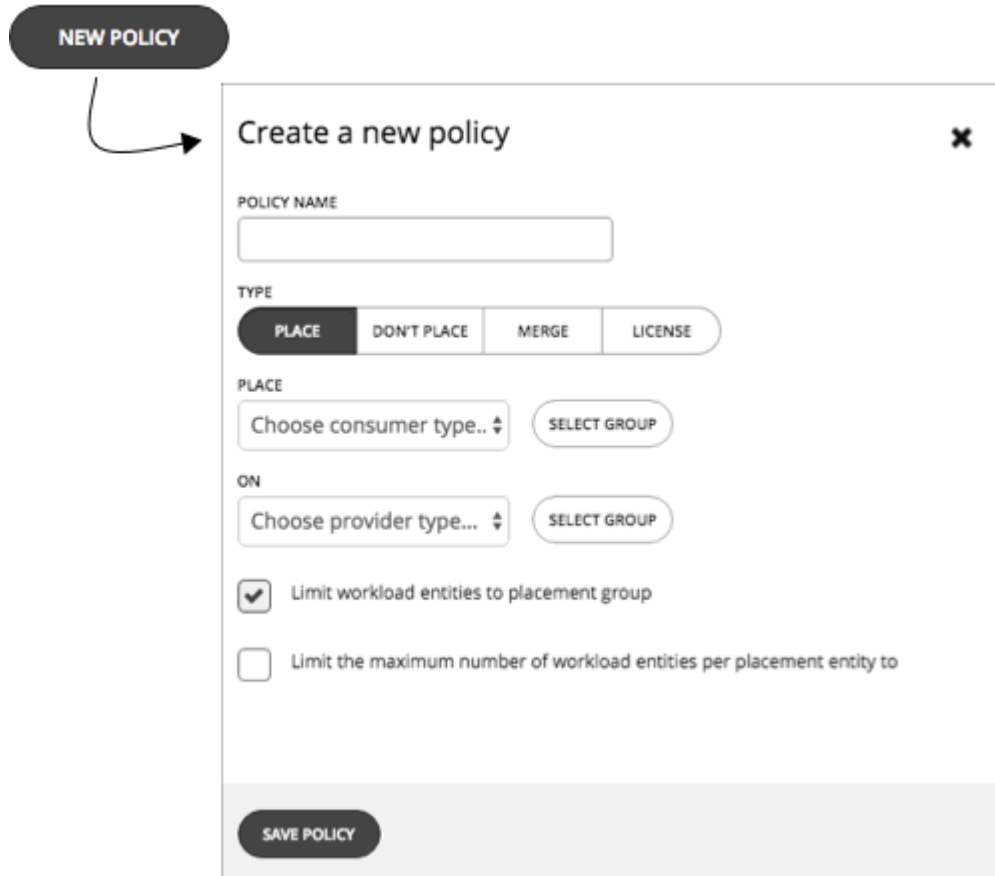
2. Choose Policies.



Click to navigate to the Policy Management Page.

This page lists all the policies that you currently have configured for Turbonomic.

3. Create a new Placement policy.



First, select the type of Placement policy to create, then specify the settings:

- Give the policy a name
- Choose the policy type and make the settings
- Save the policy when you're done


4. Create a **Place** policy.

POLICY NAME



TYPE

PLACE DON'T PLACE MERGE LICENSE

PLACE

Choose consumer type..   SELECT GROUP

ON

Choose provider type...   SELECT GROUP

☒ Limit workload entities to placement group

☐ Limit the maximum number of workload entities per placement entity to

These policies control where workload can be placed. For example, you can specify that a VM will only be placed on a host that is a member of a specific cluster. Or you could specify that any applications in a specific group can only be placed on a datastore that is a member of a specific group.

- **Specify the consumer group** — The group or cluster of entities that will be placed on the identified providers
- **Specify the provider group** — The group or cluster of entities that will provide resources to the consumers
- **Limit workload entities to placement group** — Set the policy to only place consumer entities on members of the provider group
- **Limit the maximum number of workload entities per placement entity to** — Limit how many instances of the consumer entities can be placed on a single provider



5. Create a **Don't Place** policy.

POLICY NAME



TYPE

PLACE **DON'T PLACE** MERGE LICENSE

DON'T PLACE

Choose consumer type..   SELECT GROUP

ON

Choose provider type...   SELECT GROUP

These policies identify groups or clusters that will never host the consumer entities. For example, you can specify that a VM will never be placed on a host that is a member of a specific cluster. Or you can specify that a set of non-critical applications will never be placed on specialized hardware, as a way to ensure availability for critical applications.

- **Specify the consumer group** — The group or cluster of entities that will be excluded from the identified providers
- **Specify the provider group** — The group or cluster of entities that will not provide resources to the consumers

6. Create a **Merge** policy.

POLICY NAME

TYPE

PLACE DON'T PLACE **MERGE** LICENSE

MERGE

Choose consumer type.. ▾

SELECT CLUSTERS

You can create placement policies that merge multiple clusters into a single logical group for the purpose of workload placement.

For example, your environment might divide hosts into clusters according to hardware vendor, or by some other criteria. Workload placement typically does not cross such cluster boundaries. However, there might be no technical reason to apply these boundaries to workload placement. By creating a larger pool of provider resources, Turbonomic has even more opportunities to increase efficiency in your environment.

For merge policies, keep the following considerations in mind:

- For most policies that merge host and storage clusters, the clusters you place in the Merge segment must be members of the same datacenter.
- For vCenter environments, you can create placement policies that merge datacenters to support cross-vCenter moves. In this case, where a datacenter corresponds to a given vCenter target, the merged clusters can be in different datacenters. In this case you must create two merge policies; one to merge the affected datacenters, and another to merge the specific clusters.

Also note that the clusters you merge must use the same network names on their respective datacenters.

- For cloud environments, you can create policies to merge datacenters. Use these merge policies to support VM moves that find better costs on other zones.

To create a Merge policy, choose the type of entity to merge, and then select the groups you will merge.

7. Create a **License** policy.

POLICY NAME

TYPE

PLACE DON'T PLACE MERGE **LICENSE**

LICENSE

Choose consumer type.. ▾ SELECT GROUP

ON

Choose provider type... ▾ SELECT GROUP

Assume you have purchased a number of licenses for a database – you pay for the right to run that database on a certain number of hosts. You can create a license policy to identify the hosts that provide the license, and the VMs that can consume that license.

After you create the policy, Turbonomic can recommend the following actions in response to changing demand for licenses:

- When demand is low, Turbonomic recommends consolidating VMs on as few license-providing hosts as possible to reduce your license costs. To consolidate, you move VMs to another host and then reconfigure the original hosts to remove their licenses. Note that Turbonomic will *not* recommend suspending these hosts. Since they remain active, they can be reconfigured to become providers when demand starts to exceed capacity.

For example, if you have Host_01 providing a license to VM_01 and Host_02 providing a license to VM_02, you will see two recommendations – move VM_02 to Host_01 and then remove the license in Host_01. You will not see a recommendation to suspend Host_01.

- When demand exceeds capacity, and there are hosts in the policy that currently do not provide licenses, Turbonomic recommends reconfiguring those hosts to become providers and then moving VMs to those hosts. If all hosts are currently providing licenses, Turbonomic recommends adding licenses to the hosts to meet demand.

These actions are more efficient than provisioning new hosts.

To create a License policy:

- Specify the license consumers (VMs).
- Specify the license providers (hosts).

In addition to creating a license policy, you must also create host *automation* policies to allow Turbonomic to recommend reconfigure actions on hosts. In the automation policies, add the license-providing hosts and then enable the *Reconfigure* action.

8. When you have made all your settings, be sure to save the Policy.

Automation Policies

As Turbonomic gathers metrics, it compares the metric values against specified constraint and capacity settings to determine whether a metric exhibits a problem, and what actions to recommend or execute to avoid a problem. Turbonomic uses Automation Policies to guide its analysis and resulting actions. These policies can specify:

- Action Automation

Whether to execute automatically or manually, or whether to just recommend the action. For more information, see [Action Automation](#).

- Action Scripts

Whether to have Turbonomic execute the action, or execute the action with Action Scripts. For more information, see [Deploying Action Scripts](#).

- Action Orchestration

Whether to have Turbonomic execute the action, have Turbonomic direct an orchestrator to execute the action, or execute the action with Action Scripts. For more information, see [Action Orchestration](#).

- Constraints and Other Settings

Settings that affect the Turbonomic analysis of the state of your environment. These include operational, utilization, and scaling constraints.

For more information, see [Constraints and Other Settings](#).

Default and Scoped Automation Policies

Turbonomic ships with default Automation Policy setting for the different types of entities it can discover in your environment. The settings for these default policies should be adequate to meet your initial business requirements. These policies apply to the global scope – Unless you override them, they affect all the entities in your environment. For more information, see [Working With Default Automation Policies](#).

Turbonomic can include scoped Action Policies, which override the default settings for certain entities. With these policies you specify one or more groups of entities as the policy scope. You can also set a schedule to the policy to specify maintenance windows, or to support orchestration workflows that require approval before executing the given action. For more information, see [Working With Scoped Automation Policies](#) and [Setting Policy Schedules](#).

Working With Default Automation Policies

Turbonomic ships with default Automation Policy settings for the different types of entities it can discover in your environment. The settings for these default policies should be adequate to meet your initial business requirements. These policies apply to the global scope – Unless you override their settings, they affect all the entities in your environment.

Over time you might learn that you want to make global changes to certain policy settings. For example, **Enforce Non Disruptive Mode** is turned off by default. You might learn that in most cases you want to turn it on, and only turn it off for select scopes. In that case, you would turn it on in the default Automation Policy for VMs, and then set scoped policies for those groups of VMs for which you want to turn it off.

Relationships Between Default and Scoped Policies

Your default Automation Policies and scoped Automation Policies take effect in relation to each other. A default policy has a global effect, while a scoped policy overrides the default policy for the entities within the indicated scope. You should keep the following points in mind:

- Scoped policies override a subset of settings.

A scoped policy can override a subset of settings for the entity type, and for the remainder Turbonomic will use the default policy settings on the indicated scope.

- When an entity applies conflicting scoped policies, Turbonomic applies the following tie breakers:
 - A scheduled policy always takes precedence over a non-scheduled policy, even if the non-scheduled policy is more conservative.
 - Among scheduled policies with *identical* schedules, the most conservative setting wins.
 - Among non-scheduled policies, the most conservative setting wins.

For example, a VM currently belongs to four groups with different policy settings.

- Group A policy: Resize VM in *Manual* mode every Saturday.
- Group B policy: Resize VM in *Automatic* mode every Saturday.

- Group C policy: Resize VM in *Manual* mode (no schedule).
- Group D policy: Resize VM in *Recommend* mode (no schedule).

Results:

- On a Saturday, Groups A and B policies take precedence over Groups C and D policies. The VM ultimately applies the Group A setting because it is more conservative.
- On all the other days, only Groups C and D policies are active. The VM applies the Group D setting because it is more conservative.
- Scoped policies always take precedence over default policies.

Even if the default policy has a more conservative setting, the setting in the scoped policy wins for entities in that scope.

- For a global effect, *always* use default policies.

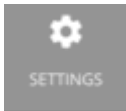
Because of the *conservative setting wins* rule for scoped policies, you should never use a scoped policy to set a global effect. For example, you can create a scoped policy for the **All VMs** group. If you then specify a conservative setting for that policy, no other scoped policy can specify a more aggressive setting – the conservative setting will always win.

For this reason, you should always use default Automation Policies whenever you want to achieve a global effect.

Viewing and Editing Default Automation Policies

To view or edit your default policies:

1. Navigate to the Settings Page.



Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

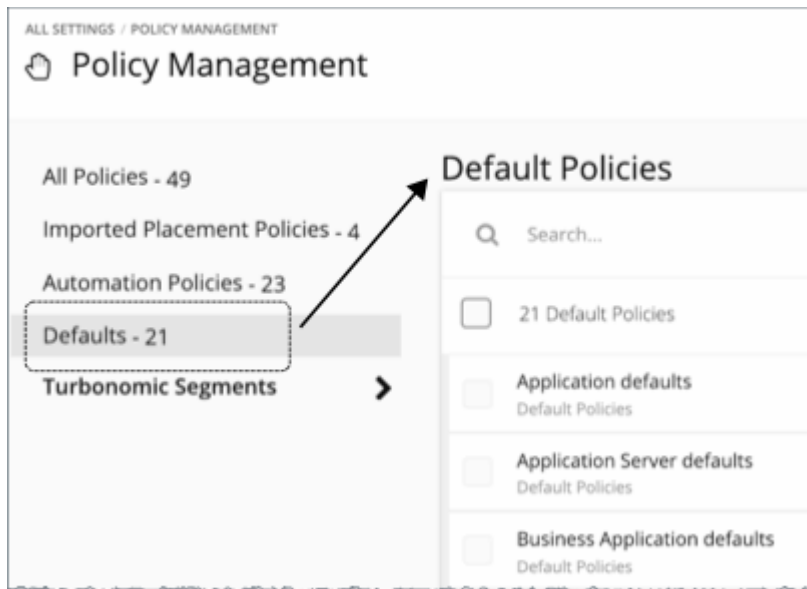
2. Choose Policies.



Click to navigate to the Policy Management Page.

This page lists all the policies that you currently have configured for Turbonomic.

3. On the Policy Management page, click **Defaults**.



The page displays a list of all the default policies, by entity type.

4. Click the entity type whose default settings you wish to view or change.

A fly-out appears with all the settings for that default policy. You can navigate to view different settings

5. Optionally, edit settings for this default policy.

Navigate to the settings you want to change, and enter a different value for each.

6. When you're done, click **Save and Apply**.

Global Default Policy

Use these settings to modify Turbonomic analysis globally for any scope of your environment. These defaults affect both scoped automation policies and default automation policies.

ACTION AUTOMATION

Disable All Actions

Attribute	Default Setting
Disable All Actions	OFF

When this is ON, Turbonomic does not generate any actions for your environment. For example, assume you have configured a number of policies that automate actions, but you want to stop making changes to the entire environment for a period of time. Turn this ON to stop all execution with a single setting.

OPERATIONAL CONSTRAINTS

VM Growth Observation Period

Attribute	Default Value
VM Growth Observation Period	1 month

Use this setting to specify how much historical data the Turbonomic analysis will use to calculate time to exhaustion of your cluster resources.

Turbonomic runs nightly plans to calculate headroom for the clusters in your on-prem environment. To review your cluster headroom in dashboards, set the view scope to a cluster. With that scope, the view includes charts to show headroom for that cluster, as well as time to exhaustion of the cluster resources.

To calculate cluster growth trends, analysis uses historical data for the given clusters. With **VM Growth Observation Period**, you can specify how much historical data the headroom analysis will use to calculate time to exhaustion of your cluster resources. For example, if cluster usage is growing slowly, then you can set the observation to a period that is long enough to capture that rate of growth.

If the historical database does not include at least two entries in the monthly data for the cluster, then analysis uses daily historical data.

Allow Unlimited Host Provisioning

Attribute	Default Setting
Allow Unlimited Host Provisioning	OFF

By default, Turbonomic allows overprovisioning hosts up to 10 times their memory capacity, and up to 30 times their CPU capacity. When this setting is ON, Turbonomic removes these overprovisioning limits to allow VM placements on already overprovisioned hosts.

This setting does not stop Turbonomic from recommending actions to provision new hosts in clusters.

Enable Analysis of On-prem Volumes

Attribute	Default Setting
Enable Analysis of On-prem Volumes	OFF

On-prem volumes represent VM Disks discovered by hypervisor targets. A VM will have one volume for each configured disk and another volume (representing the configuration) that always moves with Disk 1.

- **OFF** (default)

Turbonomic analyzes volume resources as part of VM analysis. In the real-time market and on-prem plans, any action to move VM storage ensures that volumes stay together on the underlying datastore. A Migrate to Cloud plan will recommend storage per datastore to hold all the VM Disks currently on the datastore.

For example, assume a VM with three disks. Disks 1 and 3 are on Datastore A, while Disk 2 is on Datastore B.

- During a storage migration, VM Disk volumes 1 and 3 will stay on the same datastore.
- A Migrate to Cloud plan will recommend a storage disk for VM Disk volumes 1 and 3, and another storage disk for VM Disk volume 2.

- **ON**

Turbonomic analyzes resources on each volume independently. In the real-time market and on-prem plans, any action to move VM storage migrates volumes to the most optimal datastore. A Migrate to Cloud plan will recommend storage for each volume.

For example, assume a VM with three disks. Disks 1 and 3 are on Datastore A, while Disk 2 is on Datastore B.

- During a storage migration, VM Disk volumes 1, 2, and 3 can migrate to different datastores.
- A Migrate to Cloud plan will recommend three separate storage disks for VM Disk volumes 1, 2, and 3.

Important:

When you turn on this setting, your Turbonomic instance will start to use more memory and storage to perform its analysis. For example an environment with 10,000 VMs and an average of three disks per VM represents a three-fold increase in entities that require analysis. Currently, instances that monitor more than 50,000 VMs will experience a significant drop in performance. For this reason, this setting is turned off by default.

Before turning on this setting, review your [VM automation policies](#) and verify that Storage Move actions are in *Recommend* or *Manual* mode. In addition, review your [storage placement policies](#) to ensure that individual VM volumes can be placed on the expected storage.

Working With Scoped Automation Policies

To override the current default Automation Policies, you can create scoped policies. These specify settings you want to change for certain entities in your environment. For these policies, you assign the policy to one or more groups of entities. In addition, you can assign a schedule to a scoped policy to set up maintenance windows or other scheduled actions in your environment.

Reasons to create scoped Automation Policies include:

- Change the Analysis Settings for Certain Entities

Turbonomic uses a number of settings to guide its analysis of the entities in your environment. The default settings might be fine in most cases, but you might want different analysis for some groups of entities. You can configure scoped policies to modify Operational Constraints or Scaling Constraints. For more information, see [Constraints and Other Settings](#).

- Phase In Action Automation

Assume you want to automate scaling and placement actions for the VMs in your environment. It is common to take a cautious approach, and start by automating clusters that are not critical or in production. You can scope the policy to those clusters, and set the action mode to Automatic for different actions on those VMs (see [Action Modes](#)).

- Set Up Action Scripts Entities

Scoped policies can use Action Scripts to integrate actions with other technologies, or to execute custom processes in relation to an action. For more information, see [Deploying Action Scripts](#).

For the steps to create a scoped policy, see [Creating Scoped Automation Policies](#).

Discovered Scoped Automation Policies

As Turbonomic discovers your environment, it can find configurations that set up scopes that need specific policies. For example:

- HA Configurations

For vCenter Server environments, Turbonomic discovers HA cluster settings and translates them into CPU and memory utilization constraints. The discovery creates a group of type *folder* for each HA cluster, and creates a policy that sets the appropriate CPU and memory constraints to that policy.

- Availability Sets

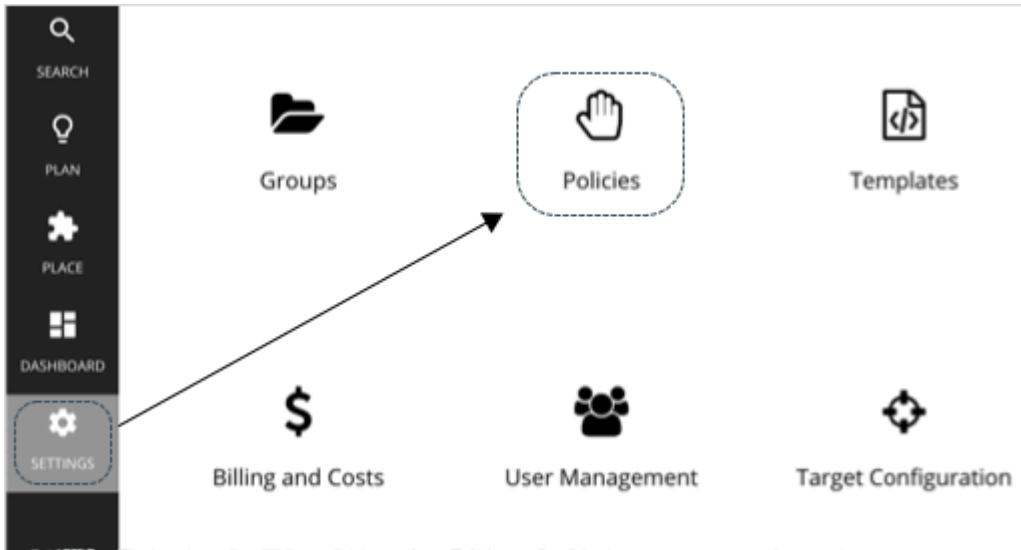
In public cloud environments, Turbonomic discovers groups of VMs that should keep all their VMs on the same template. In the Automation Policies list, these appear with the prefix *AvailabilitySet:* on the policy names. You can enable Consistent Resizing for the VMs in each group so Turbonomic can resize them to the same size.

Creating Scoped Automation Policies

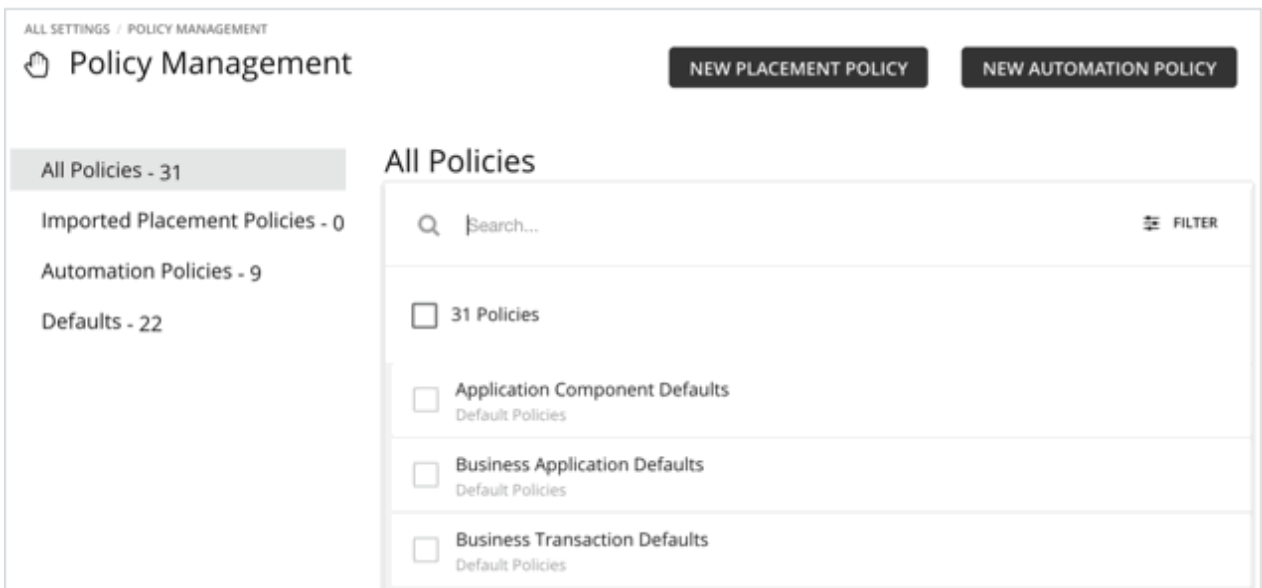
Create a new scoped Automation Policy from the Policy Management Page.

1. Entry Point

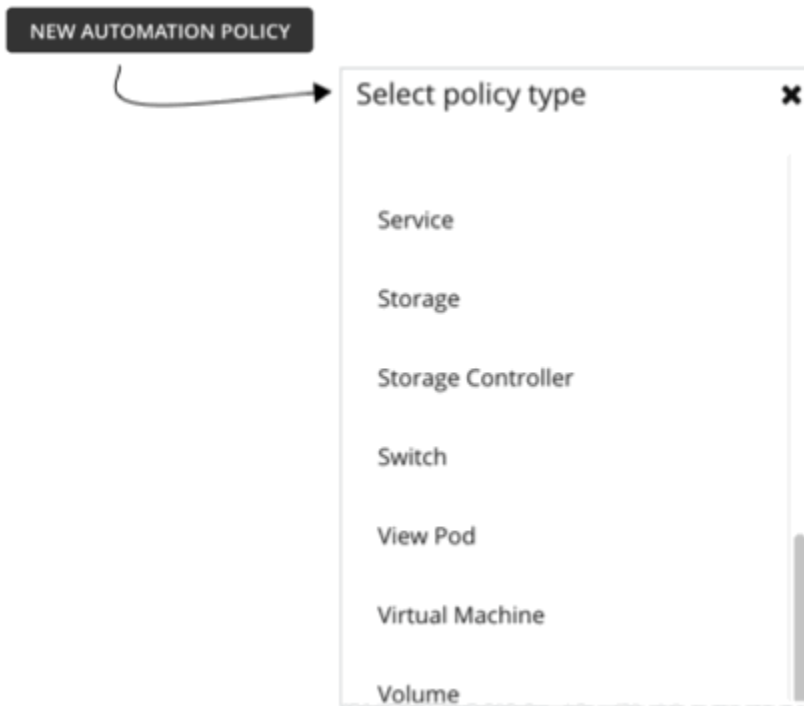
Navigate to the Settings Page and then choose **Policies**.



This opens the Policy Management Page, which lists all the currently available policies.



Click NEW AUTOMATION POLICY and then select the policy type.



This sets the type of entity that your policy will affect. Note that Turbonomic supports different actions for different types of entities. For example, you cannot add VMem to a storage device. Setting policy type is the first step you take to focus on which actions you want to map to your workflows.

2. Policy Name

Name the policy.

A screenshot of a web form titled 'Configure Virtual Machine Policy' with a back arrow and a close button (X) in the top left and right corners respectively. The form has several sections, each with a plus icon and a label: 'NAME' (with a sub-label 'NAME' and a text input field containing 'VM_Policy'), 'SCOPE', 'POLICY SCHEDULE', 'AUTOMATION AND ORCHESTRATION', 'ACTION CONSTRAINTS', 'OPERATIONAL CONSTRAINTS', and 'SCALING CONSTRAINTS'. At the bottom of the form is a 'SAVE AND APPLY' button.

3. Scope

< Configure Virtual Machine Policy X

NAME

VM_Policy

SCOPE

ACM X

ADD VIRTUAL MACHINE GROUPS

+ POLICY SCHEDULE

+ AUTOMATION AND ORCHESTRATION

+ ACTION CONSTRAINTS

+ OPERATIONAL CONSTRAINTS

+ SCALING CONSTRAINTS

SAVE AND APPLY

The scope determines which entities this policy will affect. Choose one or more groups, or create new groups and add them to the policy scope. These groups match the type of entity you have set for the policy.

In Turbonomic you can find nested groups (groups of groups). For example, the "By PM Cluster" group contains host clusters, and each host cluster is a group. Do not set the policy scope to a parent of nested groups. When setting up policies, be sure you set them to individual groups. If necessary, create a custom group for the settings you want to apply.

Note:

A single entity can be a member of multiple groups. This can result in a conflict of settings, where the same entity can have different Action Policy settings. For conflicts among scoped policy settings, the most conservative setting will take effect. For more details, see [Policy Scope](#).

4. Policy Schedule

The screenshot shows the 'Configure Virtual Machine Policy' window. The 'NAME' field contains 'VM_Policy'. The 'SCOPE' section is expanded. The 'POLICY SCHEDULE' section is selected, showing a description: 'Enables the overall policy at the scheduled time. To set when actions can execute, apply an Execution Schedule in the Automation and Orchestration section.' An arrow points from the 'ATTACH SCHEDULE' link to the 'Select Schedule' fly-out. The fly-out shows a search bar, a filter icon, and a list of schedules. The first schedule is 'Ap' (Does not recur) and is marked 'EXPIRED'. The second schedule is 'Ap 2' (Daily) and is selected. Below the list, the 'SCHEDULE DETAILS' for 'Ap 2' are shown, including a summary, 'USED IN POLICIES' (0), 'NEXT OCCURRENCE' (Saturday, December 12, 2020 at 3:30 AM (UTC)), and 'ACCEPTED ACTIONS' (0) and 'AWAITING ACCEPTANCE' (0). A 'SET' button is at the bottom of the fly-out.

Configure Virtual Machine Policy

NAME
VM_Policy

+ SCOPE

- **POLICY SCHEDULE**

Enables the overall policy at the scheduled time. To set when actions can execute, apply an Execution Schedule in the Automation and Orchestration section.

ATTACH SCHEDULE →

+ AUTOMATION AND ORCHESTRATION

+ ACTION CONSTRAINTS

+ OPERATIONAL CONSTRAINTS

+ SCALING CONSTRAINTS

SAVE AND APPLY

Select Schedule

Search... FILTER

All Schedules (21) NEW SCHEDULE

☐ Ap
Does not recur EXPIRED >

☒ Ap 2
Daily STARTS IN 8 HOURS v

SCHEDULE DETAILS

SUMMARY
Occurs every day effective Fri, Apr 3, 2020 starting at 3:30 AM and finishing same day at 5:30 AM.

USED IN POLICIES
0

NEXT OCCURRENCE

DATE	TIME
Saturday, December 12, 2020	3:30 AM (UTC)

ACCEPTED ACTIONS 0 **AWAITING ACCEPTANCE** 0

SET

For use cases and information about how schedules affect policies, see [Policy Schedules](#).

The **Select Schedule** fly-out lists all the schedules that are currently defined for your instance of Turbonomic.

Expand a schedule entry to see its details. The details include a summary of the schedule definition, as well as:

- **Used in Policies**

The number of policies that use this schedule. Click the number to review the policies.

- **Next Occurrence**

When the schedule will next come into effect.

- **Accepted Actions**

How many scheduled actions have been accepted to be executed in the next schedule occurrence. Click the number for a list of these actions.

- **Awaiting Acceptance**

The number of Manual actions affected by this schedule that are in the Pending Actions list, and have not been accepted. Click the number for a list of these actions.

If none of the listed schedules is suitable for your policy (or if none exists), click **New Schedule**. See [Creating Schedules](#).

Note:

When you configure a schedule window for a VM resize action, to ensure Turbonomic will execute the action during the scheduled time, you must turn off the **Enforce Non Disruptive Mode** setting for that scheduled policy. Even if you turn the setting off for the global policy, you still must turn the setting off for your scheduled policy. Otherwise Turbonomic will not execute the resize action.

5. Automation and Orchestration

You can define automation and orchestration settings for different action types within the same policy. For example, for a group of VMs in a policy, you can automate all *Resize* actions, but require *Suspend* actions to go through an approval process via an Orchestrator (such as ServiceNow).

Turbonomic never considers your selected actions in its calculations. For example, if you do not want to generate *Resize* actions for VMs in the policy, analysis will still drive toward the desired state, but will do so without considering resizes.

- **Generate Actions**

Turbonomic generates your selected actions to address or prevent problems. Choose from the following *Action Acceptance* modes to indicate how you would like the actions to execute:

- **Recommend** — Recommend the action so a user can execute it via the given hypervisor or by other means
- **Manual** — Recommend the action, and provide the option to execute that action through the Turbonomic user interface
- **Automatic** — Execute the action automatically

For automated resize or move actions on the same entity, Turbonomic waits five minutes between each action to avoid failures associated with trying to execute all actions at once. Any action awaiting execution stays in queue. For example, if a VM has both vCPU and vMem resize actions, Turbonomic could resize vCPU first. After this resize completes, it waits five minutes before resizing vMem.

If you have a ServiceNow target, and that target includes an installation of the *Turbonomic Actions* application, you can send the action to ServiceNow. Choose from the following options:

- Generate Action then Send Record to ServiceNow
- Generate Action then Request Approval from ServiceNow

For more information, see [Action Orchestration](#).

5.3. Before Execution, Action Execution, and After Execution

By default, generated actions execute without the need for orchestration. Turbonomic gives you the ability to set up orchestration to affect the execution of actions.

For more information, see [Action Orchestration](#).

5.4. Execution Schedule

You can defer the execution of generated actions to a non-critical time window. For example, if a workload experiences memory bottlenecks during the week, you can defer the necessary resize to the weekend. Even if the workload has minimal utilization over the weekend, Turbonomic can recognize the need to resize, and will execute the action.

For more information, see [Action Execution Schedules](#).

6. Constraints and Other Settings

The settings you can make are different according to the type of entity this policy will affect. Each setting you add to the policy takes precedence over the default value for that setting. For information about the settings you can make, see [Constraints and Other Settings](#).

Configure Virtual Machine Policy

NAME
VM_Policy

+ SCOPE

+ SCHEDULE

+ AUTOMATION AND ORCHESTRATION

- ACTION CONSTRAINTS
+ ADD ACTION

- OPERATIONAL CONSTRAINTS
+ ADD CONSTRAINT

- SCALING CONSTRAINTS
+ ADD SCALING CONSTRAINT

SAVE AND APPLY

Policy Scope

You must declare a scope whenever you make a scoped Automation Policy. The scope determines which entities will be affected by the policy settings. To set scope, you assign one or more groups to the policy. You can use discovered groups, or you can create your own groups. For information about creating groups, see [Creating Groups](#).

Relationships Between Default and Scoped Policies

Your default Automation Policies and scoped Automation Policies take effect in relation to each other. A default policy has a global effect, while a scoped policy overrides the default policy for the entities within the indicated scope. You should keep the following points in mind:

- Scoped policies override a subset of settings.
A scoped policy can override a subset of settings for the entity type, and for the remainder Turbonomic will use the default policy settings on the indicated scope.
- When an entity applies conflicting scoped policies, Turbonomic applies the following tie breakers:
 - A scheduled policy always takes precedence over a non-scheduled policy, even if the non-scheduled policy is more conservative.
 - Among scheduled policies with *identical* schedules, the most conservative setting wins.
 - Among non-scheduled policies, the most conservative setting wins.

For example, a VM currently belongs to four groups with different policy settings.

- Group A policy: Resize VM in *Manual* mode every Saturday.
- Group B policy: Resize VM in *Automatic* mode every Saturday.
- Group C policy: Resize VM in *Manual* mode (no schedule).
- Group D policy: Resize VM in *Recommend* mode (no schedule).

Results:

- On a Saturday, Groups A and B policies take precedence over Groups C and D policies. The VM ultimately applies the Group A setting because it is more conservative.
- On all the other days, only Groups C and D policies are active. The VM applies the Group D setting because it is more conservative.
- Scoped policies always take precedence over default policies.

Even if the default policy has a more conservative setting, the setting in the scoped policy wins for entities in that scope.

- For a global effect, *always* use default policies.

Because of the *conservative setting wins* rule for scoped policies, you should never use a scoped policy to set a global effect. For example, you can create a scoped policy for the **All VMs** group. If you then specify a conservative setting for that policy, no other scoped policy can specify a more aggressive setting – the conservative setting will always win.

For this reason, you should always use default Automation Policies whenever you want to achieve a global effect.

Policy Schedules

You can set a schedule for an automation policy, which sets a window of time when the policy takes effect. For example, you can modify the Operational or Scaling Constraints for a given period of time. These settings affect Turbonomic analysis, and the actions it generates. You can set up scheduled times when you want to change those settings.

Remember that for scoped automation policies, it is possible that one entity can be in two different scopes – This means the entity can be under the effect of two different policies. For this reason, scoped policies keep the rule, *the most conservative setting wins*. However, a more aggressive scoped policy takes precedence over the corresponding default automation policy. For more details, see [Policy Scope](#).

You must consider these rules when you add schedules to policies. If the more conservative settings are in a default automation policy, then the scheduled change takes effect. However, if the more conservative settings are in another scoped policy, then the conservative settings *win*, and the scheduled changes do not take effect.

Policy Schedule and Action Execution Schedule

A scheduled policy can include *actions*. When the policy is in effect, Turbonomic recommends or automatically executes those actions as they are generated. Some of those actions could be disruptive so you may want to defer their execution to a non-critical time window. In this case, you will need to set an *action execution schedule* within the scheduled policy. For example, you can set a policy that automatically resizes or starts VMs for your customer-facing apps for the entire month of December, in anticipation of an increase in demand. Within this same policy, you can set the resize execution schedule to Monday, from midnight to 7:00 AM, when demand is expected to be minimal.

For more information, see [Action Execution Schedules](#).

Action Execution Schedules

You can defer the execution of generated actions to a non-critical time window. For example, if mission-critical VMs experience memory bottlenecks during the week, you can defer the necessary memory resizes to the weekend. Even if the VMs have minimal utilization over the weekend, Turbonomic can recognize the need to resize, and will execute resize actions. For this particular example, you will need to:

1. Create a scoped policy for the VMs.
2. Select *VMem Resize Up* from the list of actions and then set the action mode to either *Automatic* or *Manual*.

Note:

Execution schedules have no effect on recommended actions. It is therefore not necessary to set up an execution schedule if all the actions in your policy will be in *Recommend* mode.

3. Set an Execution Schedule that starts on Saturday at 8:00 AM and lasts 48 hours.

Execution of Scheduled Actions

Turbonomic posts an action at the time that the conditions warrant it, which means that you might see the action in the Pending Actions list even before the execution schedule takes effect. The action details show what schedule affects the given action, and shows the next occurrence of that schedule.

- Automatic

When the schedule takes effect, Turbonomic executes any pending automated actions.

- Manual

Before the execution schedule, the action details for manually executable actions show the action state as `PENDING ACCEPT`. If you accept the action (select it and click **Apply Selected**), then Turbonomic adds it to the queue of actions to be executed during the maintenance window. The action details show the action state as `AWAITING EXECUTION`. Turbonomic executes the actions when the schedule takes effect.

Keeping Actions Valid Until the Scheduled Time

If you have scheduled action execution for a later time, then conditions could change enough that the action is no longer valid. If this happens, and the action remains invalid for 24 hours, then Turbonomic removes it from the list of pending actions. This action will not be executed.

Turbonomic includes Scaling Constraints that work to stabilize action decisions for VMs. The resulting actions are more likely to remain valid up until their scheduled window for execution. You can make these settings in default or scoped policies.

Note:

When you configure an execution schedule for a resize action, to ensure Turbonomic will execute the action during the scheduled time, you must turn off the **Enforce Non Disruptive Mode** setting for the policy. Even if you turn the setting off for the global policy, you still must turn the setting off for your policy. Otherwise Turbonomic will not execute the resize action. For information about non disruptive mode, see [Non-disruptive Mode](#).

Action Automation

To avoid problems in your environment, Turbonomic analysis identifies actions that you can execute to keep things in optimal running order. You can specify the **degree of automation** you want for these given actions. For example, in some environments you might not want to automate resize down of VMs because that is a disruptive action. You would use **action modes** in a policy to set that business rule.

Action modes specify the degree of automation for the generated actions. For example, in some environments you might not want to automate resize down of VMs because that is a disruptive action. You would use action modes in a policy to set that business rule.

Turbonomic supports the following action modes:

- Recommend — Recommend the action so a user can execute it via the given hypervisor or by other means
- Manual — Recommend the action, and provide the option to execute that action through the Turbonomic user interface

- Automatic — Execute the action automatically

For automated resize or move actions on the same entity, Turbonomic waits five minutes between each action to avoid failures associated with trying to execute all actions at once. Any action awaiting execution stays in queue. For example, if a VM has both vCPU and vMem resize actions, Turbonomic could resize vCPU first. After this resize completes, it waits five minutes before resizing vMem.

Action Mode Configuration

There are two ways to configure action modes:

- Change the action mode in a default policy. For details, see [Working With Default Automation Policies](#).
- Create an automation policy, scope the policy to specific entities or groups, and then select the action mode for each action.

Turbonomic allows you to create dynamic groups to ensure that entities discovered in the future automatically add to a group and apply the policy of that group. If a conflict arises as a result of an entity belonging to several groups, the entity applies the policy with the most conservative action.

For details, see [Creating Scoped Automation Policies](#).

Action Orchestration

Action Orchestration specifies whether Turbonomic will execute an action, or whether Turbonomic will pass the action request to an orchestrator or action script that will execute its own workflow to effect the change in your environment. In this way, you can integrate supported orchestrators to execute actions for specific scopes of entities in your environment.

About Orchestrators

Action Orchestration targets assign workflows that execute multiple actions to make changes in your environment. Turbonomic discovers workflows that you have defined on the orchestrator. You can then set up an automation policy that maps workflows to actions. If the action mode is *Manual* or *Automatic*, then when Turbonomic recommends the action, it will direct the orchestrator to use the mapped workflow to execute it.

Turbonomic supports integration with ServiceNow. You can configure policies that log Turbonomic actions in your ServiceNow instance, and that submit actions for approval in ServiceNow workflows.

This section shows how to link orchestration workflows to automation policies. It assumes you have already configured an appropriate Orchestration target. It also assumes that you have configured workflows on that target in such a way that Turbonomic can discover the workflows and map them to automation policies. For information about Orchestration target requirements, see the [Target Configuration Guide](#).

Note:

For some orchestration workflows, it is necessary to schedule an action to execute only during a specific maintenance window. Turbonomic policies can include schedules to enable this use case. However, you must be sure that you do not set the schedule to the policy that declares the orchestration you want. Instead, you should use two policies for the same scope – one to set up the orchestration, and another to schedule the time window during which the action mode will be *Automatic* (to set up the maintenance window). For more information, see [Setting Policy Schedules](#).

About Action Scripts

Action Scripts provide a script interface that can add custom processing to Turbonomic actions at different entry points. For example, you can create a script that sends an email whenever Turbonomic recommends moving a VM, or you can create a script that runs as a replacement for the action that Turbonomic would execute.

You deploy action scripts on a remote machine, and configure an Action Script target that communicates with this Action Script server. Turbonomic discovers the exposed scripts and displays them as options you can choose when you specify an Action Script in your orchestration policy.

For more information about Action Scripts, see [Deploying Action Scripts](#).

Specifying Action Orchestration

As you create a policy, you specify the entity type and the scope of entities the policy affects. You can also set modes for specific actions. For example, you can set a mode of Manual for the Resize action for a given scope of VMs.

1. Expand **Automation and Orchestration** and click **Add Action**. Then select the action type you want to orchestrate.

Configure Virtual Machine Policy

NAME

VM_Policy

+ SCOPE

+ POLICY SCHEDULE

- AUTOMATION AND ORCHESTRATION

Defines how actions are accepted.

ADD ACTION

+ ACTION CONSTRAINTS

+ OPERATIONAL CONSTRAINTS

+ SCALING CONSTRAINTS

SAVE AND APPLY

Automation and Orchestration

ACTION TYPE

Start

Move

Add a tag

ACTION GENERATION

Generate Actions

ACTION ACCEPTANCE

Automatic

BEFORE EXECUTION

Do Nothing

ACTION EXECUTION

Use Action Script

+ SELECT FILE

AFTER EXECUTION

Do Nothing

Execution Schedule

Set a schedule for when this action will be executed.

+ ADD SCHEDULE

SUBMIT

There is no orchestration for this action by default. The following table describes the supported orchestration workflows.

	Workflow 1: Generate Actions	Workflow 2: Generate Action then Send Record to ServiceNow	Workflow 3: Generate Action then Request Approval from ServiceNow
Description	Generate actions as usual, but use an Action Script to control action execution.	Send a record of the generated actions to ServiceNow.	Defer the generated actions to your ServiceNow workflow for approval. Turbonomic passes control for this action to your ServiceNow workflow as a Change Request (CR).
Prerequisites	An Action Script target	<ul style="list-style-type: none"> • A ServiceNow target that includes an installation of the <i>Turbonomic Actions</i> application • An appropriate workflow set up for Records as part of the <i>Turbonomic Actions</i> installation • An Action Script target (if using an Action Script to control action execution) 	<ul style="list-style-type: none"> • A ServiceNow target that includes an installation of the <i>Turbonomic Actions</i> application • An appropriate workflow set up for Approvals as part of the <i>Turbonomic Actions</i> installation • An Action Script target (if using an Action Script to control action execution)
Action Acceptance	Choose from the following: <ul style="list-style-type: none"> • Recommend — Recommend the action so a user can execute it via the given hypervisor or by other means • Manual — Recommend the action, and provide the option to execute that action through the Turbonomic user interface • Automatic — Execute the action automatically For automated resize or move actions on the same entity, Turbonomic waits five minutes between each action to avoid failures associated with trying to execute all actions at once. Any action awaiting execution stays in queue. For example, if a VM has both vCPU and vMem resize actions, Turbonomic could resize vCPU first. After this resize completes, it waits five minutes before resizing vMem.		Action acceptance automatically changes to "External Approval". If the action is approved, the action executes using the default Action Acceptance mode.
Before Execution	The default is Do Nothing. Select Use Action Script to run an action script that is set up for the PRE entry point. The action script name must match the entity type and action type. For example, you can post an email notification to your team that an action has been generated.		
Action Execution	The default is Native. Turbonomic executes the action with its default action processing. Select Use Action Script to let Turbonomic execute a matching action script in place of its default action processing. You must have created and deployed an action script that matches the given entry point (for action execution, REPLACE), the given action, and the given entity type.		

	Workflow 1: Generate Actions	Workflow 2: Generate Action then Send Record to ServiceNow	Workflow 3: Generate Action then Request Approval from ServiceNow
Execution Schedule	<p>There is no execution schedule by default. Turbonomic executes the action immediately.</p> <p>If the policy includes a schedule, Turbonomic executes the action at the scheduled time.</p>		<p>There is no execution schedule by default. Turbonomic executes the action immediately.</p> <p>If the policy includes a schedule, Turbonomic executes the action at the scheduled time.</p> <p>Note:</p> <p>Turbonomic discovers and enforces execution schedules defined in ServiceNow approval workflows. To avoid potential issues with schedules, set the execution schedule either in ServiceNow or Turbonomic.</p>
After Execution	<p>The default is Do Nothing.</p> <p>Select Use Action Script to run an action script that is set up for the POST entry point. The action script name must match the entity type and action type.</p>	<p>The default is Do Nothing.</p> <p>Other options include:</p> <ul style="list-style-type: none"> • Create Record in ServiceNow <p>Turbonomic registers the action in the ServiceNow log, showing that the given action has been executed.</p> <ul style="list-style-type: none"> • Use Action Script <p>Run an action script that is set up for the POST entry point. The action script name must match the entity type and action type.</p>	

2. When you have made all your settings, be sure to save the action policy.

Deploying Action Scripts

Action Scripts provide an interface that can add custom processing to Turbonomic actions.

Action scripts execute on a remote server (a VM or a container) that you have configured as a Turbonomic target. That server includes a manifest file that identifies the scripts you have deployed, as well the entities and actions they can respond to. Turbonomic discovers these scripts via the manifest and presents them as orchestration options for actions in automation policies.

For example, assume you have defined a script with:

- name: MyVmMoveAction
- entityType: VIRTUAL_MACHINE
- actionType: MOVE

Following this example, you can use the API to add orchestration to a policy for move actions on VMs. Because you have defined a script for that action, you can specify Action Script as the orchestration type, and you can choose the MyVmMoveAction script as the orchestration workflow to perform.

Setting Up the Action Script Server

Turbonomic uses remote servers to execute action scripts. Managing the processes remotely means that you do not install custom code on the Turbonomic server, which eliminates associated security risks there. However, you are responsible for maintaining the security of your action script server, to ensure the integrity of your custom code. To accomplish this, the configuration of the remote server must meet certain requirements.

Resource Requirements for the Server

The remote server can be a VM or a container. The capacity you configure for the server depends entirely on the processes you intend to run on it. Turbonomic does not impose any special resource requirements on the server.

Configuring Command Execution

To support execution of your scripts, you must install any software that is necessary to run the scripts. This includes libraries, language processors, or other processes that your scripts will invoke.

Turbonomic invokes the scripts as commands on the server. The server must run an SSH service that you have configured to support command execution and SFTP operations. At this time, IBM has tested action scripts with the OpenSSH sshd daemon.

The standard port for SSH is 22. You can configure a different port, and provide that for admins who configure the server as an Action Script target.

Note that an action script can invoke any process you have deployed on the remote server. You do not have to run scripts per se. However, you must be able to invoke the processes from the command line. The script manifest gives Turbonomic the details it needs to build the command line invocation of each script.

Configuring the Action Script User Account

To execute the scripts on your server, Turbonomic logs on via a user account that is authorized to execute the scripts from the command line. You provide the user credentials when you configure the Action Script target. To support this interaction, the user account must meet the following requirements:

- **Public Key**

The user must have a public key in the `.ssh/authorized_keys` file. When you configure the Action Script target, you provide this as the Private Token for the target.

- **Security for the `.ssh` Directory**

The Action Script User should be the only user with authorized access. You should set file permissions to 600.

- **Supported Shells**

The Action Script User shell can be either the Bourne shell (usually at `/bin/sh`) or the Bourne-Again shell (usually at `/bin/bash`). Turbonomic passes parameters as it invokes your scripts. At this time it only supports script execution through these shells.

Handling Action Script Timeouts

Turbonomic limits script execution to 30 minutes. If a script exceeds this limit, Turbonomic sends a SIGTERM to terminate the execution of the process.

Note that Turbonomic does not make any other attempt to terminate a process. For example you could implement the script so it traps the SIGTERM and continues to run. The process should terminate at the soonest safe opportunity. However, if the process does not terminate, then you must implement some way to terminate it outside of Turbonomic. Note that a runaway process continues to use its execution

thread. This can block other processes (action scripts or primary processes) if there are no more threads in the pool.

Creating Action Scripts

An action script can be any executable that a user can invoke from a command line. You can save these executable files anywhere on the server – The Manifest indicates the path to the file (see [Deploying the Action Script Manifest](#)). The Action Script user that you have configured for the script server must have access to your script files, with read and execution privileges.

To execute a script, Turbonomic builds the appropriate SSH command from the manifest information it has discovered. It grants a timeout limit of 30 minutes by default, or the manifest entry can declare a different limit. If the execution exceeds the limit, Turbonomic sends a SIGTERM to terminate the process.

Passing Information to the Action Script

Turbonomic uses two techniques to pass information about an action to the associated action script:

- Pass general information via environment variables
- Pass full action data via `stdin`

To pass general information into the script, Turbonomic sets environment variables on the Action Script server. You can reference these environment variables in your scripts. For example, assume you want to send an email that includes the name of the VM that is an action target. You can get that name via the `VMT_TARGET_NAME` environment variable.

The following list shows the environment variables that Turbonomic can set when it executes a script. Note that not all of these variables apply for every action. For example, an action to scale VMEM does not include providers, so the action does not include values for the `VMT_CURRENT_INTERNAL`, `VMT_CURRENT_NAME`, `VMT_NEW_INTERNAL`, or `VMT_NEW_NAME` variables. If a given variable does not apply, Turbonomic sets it to an empty string.

- `VMT_ACTION_INTERNAL`

The UUID for the proposed action. You can use this to access the action via the REST API. For example, your script could accept or cancel the action according to its own criteria.

- `VMT_ACTION_NAME`

The name of the action.

- `VMT_CURRENT_INTERNAL`

The internal name for the current provider.

- `VMT_CURRENT_NAME`

The display name for the current provider.

- `VMT_NEW_INTERNAL`

The internal name for the new provider.

- `VMT_NEW_NAME`

The display name for the new provider.

- `VMT_TARGET_INTERNAL`

The internal name of the entity this action will affect. You can use this to access the target entity via the REST API. For example, you can get historical statistics or you can change settings for the entity.

- `VMT_TARGET_NAME`

The display name of the entity this action will affect.

- `VMT_TARGET_UUID`

The UUID of the entity this action will affect.

For some scripts, you might need a complete description of the associated action. For example, assume you want to analyze the utilization metrics for a given resource. The environment variables for passing general information do not include this information.

When it invokes an action script, Turbonomic passes the complete data for the associated action via `stdin`. Your script can load this into a variable to access the specific data it needs. For example, the following loads `stdin` into `myActionData`:

```
myActionData=$(cat -)
```

`stdin` contains a JSON string that represents of the full data associated with this action. For example, the `myActionData` variable could contain a string similar to:

```
{"actionType": "RIGHT_SIZE", "actionItem":  
[{"actionType": "RIGHT_SIZE", "uuid": "143688943343760", "targetS  
E": {"entityType": "VIRTUAL_MACHINE", "id": "4200fcdb-eafe-2a4a-abf5-a7ad2b00555c" ...
```

Deploying the Action Script Manifest

The Action Script Manifest identifies the scripts that you want to expose to Turbonomic. You provide the location of the manifest as part of the Action Script Target configuration – After Turbonomic validates the target, it then discovers these scripts and presents them in the Orchestration Policy user interface.

Creating the Scripts Manifest File

The Scripts Manifest is a file that declares an array of Script Objects for each script you want to expose. You can create the manifest as either a JSON or a YAML file.

For example, following are two examples of the same manifest – One in YAML and the other in JSON. Notice that in either case, the manifest is an array of two Script objects:

- YAML Manifest:

```
scripts:  
- name: MyVmMovePrep  
  description: Execute this script in preperation to a VM Move  
  scriptPath: vmScripts/movePrep.sh  
  entityType: VIRTUAL_MACHINE  
  actionType: MOVE  
  actionPhase: PRE  
- name: MyVmSuspendReplace  
  description: Execute this instead of a VM Suspend action  
  scriptPath: vmScripts/suspendReplace.sh  
  entityType: VIRTUAL_MACHINE  
  actionType: SUSPEND  
  actionPhase: REPLACE
```

- JSON Manifest:

```
{  
  "scripts": [  
    {  
      "name": "MyVmMovePrep",  
      "description": "Execute this script in preperation to a VM Move",  
      "scriptPath": "vmScripts/movePrep.sh",  
      "entityType": "VIRTUAL_MACHINE",  
      "actionType": "MOVE",  
      "actionPhase": "PRE"  
    },  
    {  
      "name": "MyVmSuspendReplace",  
      "description": "Execute this instead of a VM Suspend action",  
      "scriptPath": "vmScripts/suspendReplace.sh",  
      "entityType": "VIRTUAL_MACHINE",  
      "actionType": "SUSPEND",  
      "actionPhase": "REPLACE"  
    }  
  ]  
}
```

```
}
```

You can save the Scripts Manifest file to any location on your server, so long as the Scripts User has access to that location, and has read and execute privileges. You will provide this location as the **Script Path**, which the Turbonomic administrator will give as part of the Action Script target configuration.

Note that the filename extension for the manifest must match the file format (either YAML or JSON). For example, you should name the file either `MyManifest.yaml` or `MyManifest.json`, respectively.

Declaring Script Objects

Each script object in the manifest can contain the following fields:

- **name**

Required – The name for this action script. After Turbonomic discovers your scripts, it displays this name as a Orchestration Workflow choice in the user interface for creating orchestration policies.

- **description**

Optional – A description of the script. The Turbonomic user interface does not display this description.

- **scriptPath**

Required – The path to the executable for this entry. You can give an absolute path, or a path that is relative to the location of the Scripts Manifest. The Action Script User that you set up for the Action Script server must have read and execute privileges for the executable file.

- **entityType**

Required – The type of entity this script responds to. Can be one of:

- Switch
- VIRTUAL_DATACENTER
- STORAGE
- DATABASE_SERVER
- WEB_SERVER
- VIRTUAL_MACHINE
- DISK_ARRAY
- DATA_CENTER
- PHYSICAL_MACHINE
- CHASSIS
- STORAGE_CONTROLLER
- IO_MODULE
- APPLICATION_SERVER
- APPLICATION
- CONTAINER
- CONTAINER_POD
- LOGICAL_POOL
- STORAGE_VOLUME
- DPOD
- VPOD
- DATABASE
- LOAD_BALANCER

To configure the same script to respond to actions on different entity types, declare separate entries for that script, one for each entity type.

- **actionType**

Required – The type of action this script responds to. Note that different entity types can support different actions. Can be one of:

- START
- MOVE
- SCALE

Resize on cloud - move workload from one cloud template or tier to another.

- SUSPEND
- PROVISION
- RECONFIGURE
- RESIZE
- DELETE
- RIGHT_SIZE
- ACTIVATE
- DEACTIVATE
- BUY_RI

- **actionPhase**

Required – Where in the life cycle of an action that you want your script to execute.

Can be one of:

- PRE

For an action that has been accepted, or an AUTOMATED action before it executes, this state is a preparation phase where your script can execute just before the action itself executes.

Run your script to set up conditions just before the action executes.

- REPLACE

For action execution, your script executes *in stead of* the execution that Turbonomic would perform.

Run your script as a replacement for the Turbonomic action.

- POST

The action has completed execution, either in a SUCCEEDED, FAILING, or FAILED state.

FAILING means that the status was checked after the action execution fails, but before the POST script has finished execution.

Run your script after the action has completed execution.

- **timeLimitSeconds**

Optional – How long to run the action before assuming a timeout. When execution exceeds this limit, Turbonomic sends a SIGTERM to terminate the execution of the process.

If you do not provide a value, Turbonomic assumes a limit of 30 minutes (1800 seconds).

Constraints and Other Settings

Turbonomic collects metrics to drive the analysis that it uses when it calculates actions for your environment. It compares current utilization and demand against allocated capacities for resources, so it can recommend actions that keep your environment in optimal running condition.

Action policies include constraints and other settings that you can make to adjust the analysis that Turbonomic performs. For example, you can set different levels of overprovisioning for host or VM resources, and Turbonomic will consider that as a factor when deciding on actions.

Turbonomic ships with default policies that show all the constraints and settings you can make for each policy. These take effect until you create and apply a policy with different values. For the steps in creating a new policy, see [Creating Scoped Automation Policies](#). You can edit the defaults if you want to change analysis globally.

Chapter 6. Target Configuration

A target is a service that performs management in your virtual environment. Turbonomic uses targets to monitor workload and to execute actions in your environment. Target Configuration specifies the ports Turbonomic uses to connect with these services. You must install Turbonomic on a network that has access to the specific services you want to set up as targets.

For each target, Turbonomic communicates with the service via the management protocol that it exposes — The REST API, SMI-S, XML, or some other management transport. Turbonomic uses this communication to discover the managed entities, monitor resource utilization, and execute actions.

Note:

Turbonomic does not support duplicate instances of the same target. When configuring targets, you must not configure two or more targets to the same address in your environment. For example, you must not configure two different targets to the same AWS account, nor two targets to the same vCenter Server instance.

If you do configure duplicate targets, then actions can fail to execute with an error that begins: `AnalysisException occurred...`

To resolve this issue, identify the duplicate targets, and delete them until you have only one target for each address.

You can assign instances of the following technologies as Turbonomic targets:

- Applications and Databases
 - Apache Tomcat 7.x, 8.x, and 8.5.x
 - AppDynamics 4.1+
 - AppInsights
 - Dynatrace 1.1+
 - IBM WebSphere Application Server 8.5+
 - Instana, release-209 or later
 - JBoss Application Server 6.3+
 - JVM 6.0+
 - Microsoft SQL Server 2012, 2014, 2016, 2017, and 2019
 - MySQL 5.6.x and 5.7.x
 - NewRelic
 - Oracle 11g R2, 12c, 18c, and 19c
 - Oracle WebLogic 12c
- Cloud Native
 - Kubernetes, including any compliant k8s distribution (Rancher, Tanzu, open source, etc.)
 - Cloud-hosted k8s services (AKS, EKS, GKE, IBM, Cisco IKS, ROKS, ROSA, etc.)
 - OpenShift 3.11 and higher (OCP 4.x)
- Fabric and Network
 - Cisco UCS Manager 3.1+
 - HPE OneView 3.00.04
- Guest OS Processes
 - SNMP
 - WMI: Windows versions 8 / 8.1, 10, 2008 R2, 2012 / 2012 R2, 2016, 2019 and 7

- Hyperconverged
 - Cisco HyperFlex 3.5
 - Nutanix Community Edition
 - VMware vSAN
- Hypervisors
 - Microsoft Hyper-V 2008 R2, Hyper-V 2012/2012 R2, Hyper-V 2016, Hyper-V 2019
 - VMware vCenter 6.0, 6.5, 6.7, and 7.0+
- Orchestrator
 - Action Script
 - Flexera One
 - ServiceNow
- Private Cloud
 - Microsoft System Center 2012/2012 R2 Virtual Machine Manager and System Center 2016 Virtual Machine Manager
- Public Cloud
 - Amazon AWS
 - Amazon AWS Billing
 - Google Cloud Platform (GCP)
 - Google Cloud Platform (GCP) Billing
 - Microsoft Azure Service Principal
 - Microsoft Enterprise Agreement
- Storage
 - EMC ScaleIO 2.x and 3.x
 - EMC VMAX using SMI-S 8.1+
 - EMC VPLEX Local Architecture with 1:1 mapping of virtual volumes and LUNs
 - EMC XtremIO XMS 4.0+
 - HPE 3PAR InForm OS 3.2.2+, 3PAR SMI-S, 3PAR WSAPI
 - IBM FlashSystem running on Spectrum Virtualize 8.3.1.2 or later (8.4.2.0 or later recommended)
 - NetApp Cluster Mode using ONTAP 8.0+ (excluding AFF and SolidFire)
 - Pure Storage F-series and M-series arrays
- Virtual Desktop Infrastructure
 - VMware Horizon

Transport Layer Security Requirements

Turbonomic requires Transport Layer Security (TLS) version 1.2 to establish secure communications with targets. Most targets should have TLS 1.2 enabled. However, some targets might not have TLS enabled, or they might have enabled an earlier version. In that case, you will see handshake errors when Turbonomic tries to connect with the target service. When you go to the Target Configuration view, you will see a Validation Failed status for such targets.

If target validation fails because of TLS support, you might see validation errors with the following strings:

- No appropriate protocol

To correct this error, ensure that you have enabled the latest version of TLS that your target technology supports. If this does not resolve the issue, please contact IBM Technical Support.

- Certificates do not conform to algorithm constraints

To correct this error, refer to the documentation for your target technology for instructions to generate a certification key with a length of 2048 or greater on your target server. If this does not resolve the issue, please contact IBM Technical Support.

Adding and Removing Targets

The target services your Turbonomic installation will manage appear in the Target Configuration list. You can add, remove, and edit entries in this list. Note that the target service's account must be configured with privileges that support the Turbonomic activities you want to perform. For example, the following list shows how vCenter privileges correspond to activities Turbonomic can perform:

- **Read Only** — Enables Turbonomic monitoring and simulation (what-if scenarios) only
- **vCenter Administrator** — Enables Turbonomic monitoring, simulation (what-if scenarios), and automation functions
- **Enable Datastore Browse** — Enabling this property for the account gives Turbonomic the privileges it needs to enable its storage management functionality

Adding Targets

To add a target service, click the **Target Configuration** button, provide the requested information, and click **Apply** to validate those targets and start a new discovery.

Note:

As you add targets, be sure not to add duplicate entries for the same target.

Typical information you provide includes:

- **Target Type** — Choose among the supported technologies
After you choose the technology, then choose the specific target type for that technology. For example, for Cloud Management, you can choose AWS.
- **Hostname or IP address** — The address of the target service you want to add
- **User Name** — A valid account username for the target service
- **Password** — A password for the target service account

Removing Targets

To remove a target, select the entry in the list and then click **Delete**.

Applications and Databases Targets

Applications and Databases targets support domains of particular application servers that are controlled by management servers. For such managed domains you will add the management server as a target, and Turbonomic will discover the managed application servers.

Note:

As it manages your applications environment, Turbonomic discovers connected application components to stitch them into a supply chain of entities. For connections that are made by name and not IP address, Turbonomic makes DNS calls to resolve these names to IP addresses. This can happen during repeated discovery cycles.

Supply Chain

Applications and Databases targets add Business Application, Business Transaction, Service, Application Component, Application Server, and Database Server entities to the supply chain. You can navigate to the associated target page to see how these entities map to the target nomenclature.

Cisco AppDynamics

Turbonomic supports workload management of the application infrastructure monitored by AppDynamics, via adding the AppDynamics instance to Turbonomic as a target.

The Turbonomic integration with AppDynamics provides a full-stack view of your environment, from application to physical hardware. With information obtained from AppDynamics, Turbonomic is able to make recommendations and take actions to both assure performance and drive efficiency with the full knowledge of the demands of each individual application.

In its default configuration, the AppDynamics target will collect up to 1100 AppDynamics nodes within the default collection period when a proxy is used, and up to 5000 nodes when no proxy is required. Larger AppDynamics environments are expected to take longer than one cycle to collect complete data.

Note:

For Kubernetes environments, Turbonomic stitches NewRelic, AppDynamics, Instana, and Dynatrace containerized application components into the supply chain to provide a unified view of your applications. For more information, see [Cloud Native Targets](#).

Prerequisites

- A valid AppDynamics user account.

For all types of application instances, the service account must have the `Read Only User` role. For monitoring database instances, this user must also have the `DB Monitoring User` role.

Note:

In newer versions of AppDynamics where these roles are available, they should be used instead:

- Applications and Dashboards Viewer
- DB Monitoring User
- Server Monitoring

To use a custom role, ensure that the role has the `View Server Visibility` permission for both applications and databases.

AppDynamics Database Servers

AppDynamics also monitors database servers. In order for your database servers to be correctly stitched to the rest of your environment, you must:

- Enable enhanced metric collection.

For Hyper-V hosts, you must install Hyper-V Integration Services on the target VM hosting the database. For more information, please refer to the following integration services TechNet article:

<https://technet.microsoft.com/en-us/library/dn798297%28v=ws.11%29.aspx>

For VMware hosts, you must install VMware Tools on the target VMs.

- Ensure that the database name in AppDynamics is resolvable to an IP address by the Turbonomic instance.

You may need to make changes to your DNS or the file `/etc/resolv.conf` on the Turbonomic instance.

Entity Mapping

After validating the new target, Turbonomic discovers the connected entities. The following table describes the entity mapping between the target and Turbonomic:

AppDynamics	Turbonomic
Business Application	Business Application
Business Transaction	Business Transaction
Tier	Service
Node	Application Component
Database	Database Server
Machine (when the machine type is Container)	Container
Server	Virtual Machine

Adding an AppDynamics Target

Note:

It is possible to monitor certain applications or database servers with both AppDynamics and Turbonomic, but this must be avoided as it will cause the entities to appear duplicated in the market.

If an application is monitored by AppDynamics, do not add it as a separate Turbonomic application target.

To add an AppDynamics instance as a target, specify:

- Hostname or IP Address

The host name or IP Address of the AppDynamics controller instance.

- Port

the port used to connect to the AppDynamics controller. By default, this is set to ports 80 (HTTP) and 443 (HTTPS).

Note: For SaaS-based AppDynamics instances, you must use port 443.

- Username or API Client Name@Account

Username and account ID with the necessary role(s). The format must be *Username@Tenant*, and the user must have the "Read Only User" and "DB Monitoring User" permissions. This username can be found on the "License > Account" page in AppDynamics. For OAuth authentication, the username must be a user defined as an API Client.

Note:

The username and password cannot contain any of the following special characters:

\ / " [] : | < > + = ; , ? * , ' tab space @

- Password or Client Secret

Password for the account used to connect to the AppDynamics instance. For OAuth, this will be the client secret key.

Note:

The username and password cannot contain any of the following special characters:

\ / " [] : | < > + = ; , ? * , ' tab space @

- Collect Virtual Machine Metrics

Whether to collect VM metrics from this target. When **Collect Virtual Machine Metrics** is turned on, Turbonomic uses the VM metrics it collects from this target, instead of the matching data it collects from the underlying VM's hypervisor or cloud provider target.

- Secure Connection

When checked, Turbonomic will connect via HTTPS. Make sure the required certificate is configured for use on the host.

- Use API Client (OAuth)

When checked, enables Open Authorization (OAuth) token-based authentication for the target connection.

- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the AppDynamics instance via a proxy.

- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.

- Proxy Username

The username to use with the proxy specified above.

- Proxy Password

The password to use with the proxy specified above.

- Secure Proxy Connection

When checked, Turbonomic will connect to the proxy via HTTPS.

For more information about creating API client users, see the [AppDynamics Documentation](#).

Actions

Note:

The specific actions that Turbonomic recommends can differ, depending on the processes that Turbonomic discovers. For entities that you can add as individual targets, find the list of related actions in the sections for that target type in the *Target Configuration Guide*.

For other application components, Turbonomic can recommend actions based on the resources it can discover for the application. For example, Node.js® applications report CPU usage, so Turbonomic can generate vCPU resize actions and display them in the user interface.

Turbonomic recommends actions for the AppDynamics supply chain as follows.

Application Component

- Suspend VM
Recommendation only.
- Provision VM
Recommendation only.

Database Server

- Resize DB Mem
Recommendation only.
- Resize Connections
Recommendation only.
- Resize Transaction Log
Recommendation only.

Note:

For different types of Database Servers, the AppDynamics target returns different metrics. This affects Turbonomic actions as follows:

- MySQL:

For MySQL database servers, analysis does not generate resize actions for DB Memory or Connections. The target does not discover DB Cache Hit Rate, DB Memory, or Connections.

- Microsoft SQL Server:

For Microsoft SQL database servers, analysis does not generate resize actions for DB Memory or Connections. The target does not discover DB Memory or Connections.

- MongoDB:

For MongoDB database servers, analysis does not generate resize actions for DB Memory or Transaction Log. The target does not discover DB Cache Hit Rate, DB Memory, Transactions, or Transaction Log.

- Oracle:

For Oracle database servers, analysis does not generate resize actions for DB Memory, Connections, or Transaction Log. The target does not discover DB Memory, Connections, or Transaction Log.

Monitored Resources

Note:

The exact resources this target monitors can differ based on application type. The following list of metrics per entity includes all resources you might see.

For a given VM, the resources you see depend on how the VM is discovered, and whether the VM provides resources for an application discovered by this target:

- If the VM hosts an application that is discovered through this target, then you will see VM metrics discovered through this target.
- If the VM is discovered through a different target, and it does not host any application discovered through this target, then you will see VM metrics discovered through that different target.
- If the VM is discovered through this target, but it does not host any application discovered through this target, then Turbonomic does not display metrics for the VM.

Turbonomic monitors the following resources for the AppDynamics supply chain:

Business Transaction

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Transactions

The utilization of the allocated transactions per second for the given business transaction

Measured in transactions per second

Business Applications

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Transactions

The utilization of the allocated transactions per second for the given virtual application

Measured in transactions per second

Service

- Response Time

Response time (in milliseconds) for the given service

For Kubernetes, this is the desired *weighted average* response time of all Application Component replicas associated with a Service

- Transactions

Transactions per second for the given service

For Kubernetes, the maximum number of transactions per second that each Application Component replica can handle.

Application Component

- Virtual CPU (VCPU)

The utilization of the VCPU allocated to the hosting VM

Measured in Megahertz (MHz)

Note: This commodity is collected for Java, .NET, and Node.js applications only.

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

Measured in Kilobytes (KB)

Note: This commodity is collected for Java, .NET, and Node.js applications only.

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second

- Heap

The utilization of the application component's heap

Measured in Kilobytes (KB)

Note: This commodity is collected for Java, .NET, and Node.js applications only.

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Connections

The utilization of the connection capacity. Only applicable to database servers

Measured in Connections

- Remaining Garbage Collection Capacity

The percentage of server uptime spent not performing garbage collection

Measured in uptime (%)

- Threads

The utilization of the server's thread capacity

Measured in number of Threads

Database Server

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

Measured in Kilobytes (KB)

Note:

Requires a machine agent present, and database hardware monitoring to be enabled.

- Virtual CPU (VCPU)

The utilization of the VCPU allocated to the hosting VM

Measured in Megahertz (MHz)

Note:

Requires a machine agent present, and database hardware monitoring to be enabled.

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second

Note:

For Microsoft SQL Server, MySQL, and Oracle databases, only.

- Connections

The utilization of the connection capacity. Only applicable to database servers

Measured in Connections

Note:

For Mongo databases only.

- Transaction Log

The utilization of the server's capacity for storage devoted to transaction logs

Measured in Kilobytes (KB)

Note:

For Microsoft SQL Server and MySQL databases, only.

- DB Cache Hit Rate

The percentage of accesses that result in cache hits.

Measured as a percentage of hits vs total attempts (%)

Note:

For Microsoft SQL Server and Oracle databases, only.

Virtual Machine

- Virtual CPU (vCPU)

The utilization of the VCPU of the virtual machine. Measured in %.

- Virtual Memory (vMem)

The utilization of the VMEM of the virtual machine. Measured in Kilobytes (KB).

Application Insights

Turbonomic supports workload management of the application infrastructure monitored by Application Insights via the Turbonomic integration, which provides a full-stack view of your environment, from application to hosting server. With information obtained from Application Insights, Turbonomic is able to make recommendations and take actions to both assure performance and drive efficiency with the full knowledge of the demands of each individual application.

Prerequisites

- A valid Application Insights user account with the same permissions detailed for [Microsoft Azure](#) targets.

Entity Mapping

After validating the new target, Turbonomic discovers the connected entities. The following table describes the mapping of entities between the target and Turbonomic:

Application

Application, Application Server

Adding an Application Insights Target

Note:

If an application is monitored by Application Insights or Azure, do not add it as a separate Turbonomic application target.

To add Application Insights as a target, specify:

- Unique Target Description
A user-created name that will appear in the Turbonomic UI.
- Tenant Name
The tenant associated to the Azure subscription associated to Application Insights.
- Azure Subscription ID
The ID of the Azure subscription with access to the Azure target associated to Application Insights.
- Client ID
The Client ID of the App registration that gives Turbonomic access to resources in your Azure subscription.
- Client Secret Key
The secret key for the App registration.
- Offer ID
If applicable, the Azure Offer ID related to the Azure subscription.
- Enrollment Number
If an Azure EA account, the enrollment number associated to the Azure subscription.
- Proxy Host
The address of the proxy used for this target. Only fill out proxy information if you connect to the AppDynamics instance via a proxy.
- Proxy Port
The port to use with the proxy specified above. By default, this is 8080.
- Proxy Username
The username to use with the proxy specified above.
- Proxy Password
The password to use with the proxy specified above.
- Secure Proxy Connection
When checked, Turbonomic will connect to the proxy via HTTPS.

Stitching Application Insights Applications to the Turbonomic Environment

Each application monitored by Application Insights can have several associated applications, and each of these applications can be deployed on a different hosting server. Likewise, a hosting server may host multiple groups or partial groups of multiple applications.

In order to accurately stitch metrics from Application Insights, the host name or IP address of the hosting server must be discoverable through the Application Insights instance. For most monitored application instances, this is automatic. If the hosting server is not discoverable, Azure tags on the application can be provided to indicate the IP address or hostname.

You can provide an Azure tag in the following name : value format:

```
Turbonomic-Host-Name :  
RoleInstance=hostname;RoleInstance=hostname;RoleInstance=hostname;
```

In the preceding example, RoleInstance is the name of the application instance, and hostname is the hosting server. For example: Turbonomic-Host-Name : cluster-app-a=120.120.120.10;cluster-app-b=120.120.120.11;cluster-app- c=120.120.120.12;.

Note: If these tags are provided, they will replace any values discovered through the Application Insights API.

Actions

Note:

The specific actions that Turbonomic recommends can differ, depending on the processes that Turbonomic discovers. For entities that you can add as individual targets, find the list of related actions in the sections for that target type in the *Target Configuraton Guide*.

For other application components, Turbonomic can recommend actions based on the resources it can discover for the application. For example, Node.js® applications report CPU usage, so Turbonomic can generate vCPU resize actions and display them in the user interface.

Application Component

- Suspend VM
Recommendation only.
- Provision VM
Recommendation only.

Monitored Resources

Note:

The exact resources monitored will differ based on application type. This list includes all resources you may see.

Turbonomic monitors the following resources for the Application Insights supply chain:

Application Component

- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)
- Transactions
The utilization of the allocated transactions per second for the given entity
Measured in transactions per second
- Response Time
The utilization of the server's allocated response time
Measured in Milliseconds (ms)

New Relic

Turbonomic supports workload management of the application infrastructure monitored by New Relic, from application instance to host. With information obtained from New Relic, Turbonomic can make recommendations and take actions to both assure performance and drive efficiency to address the demands of each individual application. For Kubernetes environments, Turbonomic stitches containerized application components into the supply chain to provide a unified view of your applications.

Note:

For Kubernetes environments, Turbonomic stitches NewRelic, AppDynamics, Instana, and Dynatrace containerized application components into the supply chain to provide a unified view of your applications. For more information, see [Cloud Native Targets](#).

Prerequisites

- A valid New Relic user account that includes both APM and infrastructure monitoring.

Entity Mapping

After validating the new target, Turbonomic discovers the connected entities. The following table describes the mapping of entities between the target and Turbonomic:

New Relic Term	Turbonomic Term
APM: Key Transactions	Business Transaction
APM: Application / Service (New Relic One)	Service
APM: Application Instance	Application Component
Infra: Database	Database Server
Infra: Host	Virtual Machine

For VM entities

Supported Applications

Turbonomic discovers the following application types (and associated commodities) via the New Relic target:

Application Type	Commodities
.NET	Virtual CPU, Virtual Memory, Response Time, Transactions
GO	Virtual CPU, Virtual Memory, Response Time, Transactions
Java	Virtual CPU, Virtual Memory, Response Time, Transactions, Heap, Collection Time, Threads
Node.js	Virtual CPU, Virtual Memory, Response Time, Transactions, Heap, Collection Time
PHP	Virtual CPU, Virtual Memory, Response Time, Transactions
Python	Virtual CPU, Virtual Memory, Response Time, Transactions

Supported Databases

Turbonomic supports the following Database types and commodities:

Note: Database commodities are exposed only if the New Relic account used to connect to Turbonomic has a New Relic Infrastructure Pro subscription.

Database	Commodities
MS SQL	Cache Hit Rate, Virtual Memory, Transactions
MySQL	Cache Hit Rate
OracleDB	Cache Hit Rate, Transactions, Response Time
MongoDB	Virtual Memory, Connections

Adding a New Relic Target

Note:

If an application is monitored by New Relic, do not add it as a separate Turbonomic application target.

To add New Relic as a target, specify:

- Account ID

The New Relic Account ID.

- REST API Key

The REST API Key *provided by the New Relic platform*. For more information, see [New Relic API Keys](#).

- GraphQL API Key

The GraphQL API Key *provided by the GraphQL service*. This is not identical to the REST API Key above. For more information, see [Generate a new API key in the GraphQL Explorer](#).

- EU Region

If checked, Turbonomic will use the EU API endpoints.

- Collect Virtual Machine Metrics

Whether to collect VM metrics from this target. When **Collect Virtual Machine Metrics** is turned on, Turbonomic uses the VM metrics it collects from this target, instead of the matching data it collects from the underlying VM's hypervisor or cloud provider target.

- Proxy Host (Optional)

The IP of the Proxy Host.

- Proxy Port (Optional)

The port required by the proxy.

- Proxy Username (Optional)

The username required by the proxy.

- Proxy Password (Optional)

The password required by the proxy.

- Secure Proxy Connection

When checked, Turbonomic will connect to the proxy via HTTPS.

Actions

Note:

The specific actions that Turbonomic recommends can differ, depending on the processes that Turbonomic discovers. For entities that you can add as individual targets, find the list of related actions in the sections for that target type in the *Target Configuration Guide*.

For other application components, Turbonomic can recommend actions based on the resources it can discover for the application. For example, Node.js® applications report CPU usage, so Turbonomic can generate vCPU resize actions and display them in the user interface.

Turbonomic recommends actions for the New Relic supply chain as follows.

Application Component

- Suspend VM
Recommendation only.
- Provision VM
Recommendation only.

Monitored Resources

Note:

The exact resources this target monitors can differ based on application type. The following list of metrics per entity includes all resources you might see.

For a given VM, the resources you see depend on how the VM is discovered, and whether the VM provides resources for an application discovered by this target:

- If the VM hosts an application that is discovered through this target, then you will see VM metrics discovered through this target.
- If the VM is discovered through a different target, and it does not host any application discovered through this target, then you will see VM metrics discovered through that different target.
- If the VM is discovered through this target, but it does not host any application discovered through this target, then Turbonomic does not display metrics for the VM.

Turbonomic monitors the following resources for the New Relic supply chain:

Application Component

- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)
- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Transactions
Turbonomic discovers *key* transactions – transactions that the user marked as *key* to the application
The utilization of the allocated transactions per second for the given entity
Measured in transactions per second
- Heap
The utilization of the application server's heap
Measured in Kilobytes (KB)
- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Connections

The utilization of the connection capacity. Only applicable to database servers

Measured in Connections

- Remaining Garbage Collection Capacity

The percentage of server uptime spent not performing garbage collection

Measured in uptime (%)

- Threads

The utilization of the server's thread capacity

Measured in number of Threads

Database

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

Measured in Kilobytes (KB)

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second.

- DBMem

The memory utilized by the database, as a percentage of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM.

- Connections

The utilization of the connection capacity. Only applicable to database servers

Measured in Connections

- DB Cache Hit Rate

The percentage of accesses that result in cache hits.

Measured as a percentage of hits vs total attempts (%)

Business Transaction

- Response Time

The utilization of the server's allocated response time. Measured in milliseconds (ms).

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second.

Service

- Response Time

The utilization of the server's allocated response time. Measured in milliseconds (ms).

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second.

Virtual Machine

- Virtual CPU (vCPU)

The utilization of the VCPU of the virtual machine. Measured in %.

- Virtual Memory (vMEM)

The utilization of the VMEM of the virtual machine. Measured in Kilobytes (KB).

Dynatrace

Turbonomic supports discovery of applications that are managed by the Dynatrace platform. Turbonomic includes the discovered information about these applications in its calculations for VM actions.

Note:

For Kubernetes environments, Turbonomic stitches NewRelic, AppDynamics, Instana, and Dynatrace containerized application components into the supply chain to provide a unified view of your applications. For more information, see [Cloud Native Targets](#).

Prerequisites

- A Dynatrace Server instance

This instance must be configured to monitor applications running in your environment.

Turbonomic supports both SaaS and on-prem Dynatrace server installations.

- Managed VMs that host applications managed by Dynatrace

For Turbonomic to discover applications through Dynatrace, the applications must be running on VMs in your environment. Also, these VMs must be managed by Turbonomic targets such as hypervisors or public cloud targets.

- A valid Dynatrace user account

The account must provide read-only access to the application data your Dynatrace server collects. It must enable the following switches for the access scope of the Dynatrace API token:

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none">– Dynatrace API V1:<ul style="list-style-type: none">- DataExport– Dynatrace API V2:<ul style="list-style-type: none">- metrics.read

Entity Mapping

After validating the new target, Turbonomic discovers the connected entities. The entity names that Turbonomic displays in the Supply Chain differ from the entity names that Dynatrace displays in its user interface, as follows:

Dynatrace Naming	Turbonomic Entity
Application	Business Application Note: For Dynatrace Applications, Turbonomic displays Business Application entities in the supply chain when they have been active for at least three days.
Service	Service

Dynatrace Naming	Turbonomic Entity
Process	Application Component, Database Server
NA	Container
Host	Virtual Machine

Adding a Dynatrace Target

Note:

You can manage certain applications or database servers with both Dynatrace and Turbonomic. You should avoid such a configuration because it can cause Turbonomic to generate duplicate entities in the market.

If you manage an application via a Dynatrace server, and you configure that Dynatrace server as a Turbonomic target, then be sure you have *not* added that application as a separate application target in Turbonomic.

To add a Dynatrace server instance as a target, specify:

- Hostname or IP Address

For an on-prem installation of DynaTrace, give the host name or IP and endpoint, separated by a slash. For example, `10.10.10.10/e/b70e3eb2-e82b-4c13-a5a4-560d9865841r`.

For a SaaS installation, provide the URL *without* the `{IP_ADDRESS}/e/` statement in the path. For example, `ayz12745.live.dynatrace.com`

- API Token

The token that Turbonomic can use to authenticate its calls to the Dynatrace API. This token must have permission to execute GET methods via the Dynatrace API.

- Collect Virtual Machine Metrics

Whether to collect VM metrics from this target. When **Collect Virtual Machine Metrics** is turned on, Turbonomic uses the VM metrics it collects from this target, instead of the matching data it collects from the underlying VM's hypervisor or cloud provider target.

- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the Dynatrace server via a proxy.

- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.

- Proxy Username

The username for the account to log into the proxy specified above.

- Proxy Password

The password to use with the proxy specified above.

- Secure Proxy Connection

Whether to use a secure connection with the proxy. When this is turned on, Turbonomic connects to the proxy through HTTPS.

Dynatrace Permissions

The account that Turbonomic uses to connect with a Dynatrace target must include the following permissions:

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none"> Dynatrace API V1: <ul style="list-style-type: none"> DataExport Dynatrace API V2: <ul style="list-style-type: none"> metrics.read

Actions

Entity:	Actions:
Application Component	<ul style="list-style-type: none"> Resize <ul style="list-style-type: none"> Heap <p>Turbonomic will recommend Heap resize actions if the Application Component sells Heap and Remaining Garbage Collection (GC) Capacity, and the underlying VM or container sells VMem.</p> <p>Recommended, only.</p>

Monitored Resources

Note:

The subset of resources that Turbonomic discovers for an application depends on the application type. The following list of metrics per entity includes the full set of resources Turbonomic can discover for Dynatrace applications.

For Database Server applications, Turbonomic only discovers metrics for MySQL and MSSQL databases.

For a given VM, the resources you see depend on how the VM is discovered, and whether the VM provides resources for an application discovered by this target:

- If the VM hosts an application that is discovered through this target, then you will see VM metrics discovered through this target.
- If the VM is discovered through a different target, and it does not host any application discovered through this target, then you will see VM metrics discovered through that different target.
- If the VM is discovered through this target, but it does not host any application discovered through this target, then Turbonomic does not display metrics for the VM.

Turbonomic monitors the following resources for the Dynatrace supply chain:

Business Application

- Response Time
 - The utilization of the server's allocated response time
 - Measured in Milliseconds (ms)
- Transactions
 - The utilization of the allocated transactions per second for the given entity
 - Measured in transactions per second

Service

- Response Time
 - The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second

Application Component

- Virtual CPU (vCPU)

The utilization of the VCPU for the given entity. Measured in %.

- Virtual Memory (vMem)

The utilization of the VMEM for the given entity. Measured in Kilobytes (KB).

- Remaining Garbage Collection Capacity

The percentage of server uptime spent not performing garbage collection

Measured in uptime (%)

Note:

This commodity is for Java applications, only.

- Heap

The utilization of the application server's heap

Measured in Kilobytes (KB)

Note:

This commodity is collected for Java applications only.

Database Server

- Virtual CPU (vCPU)

The utilization of the VCPU for the given entity. Measured in %.

- Virtual Memory (vMem)

The utilization of the VMEM for the given entity. Measured in Kilobytes (KB).

- DBMem

For Microsoft SQL and MySQL, only.

The memory utilized by the database, as a percentage of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM.

- DB Cache Hit Rate

For Microsoft SQL, only.

The percentage of accesses that result in cache hits.

Measured as a percentage of hits vs total attempts (%)

- Transactions

For Microsoft SQL, only.

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second

Container

- Virtual CPU (vCPU)

The utilization of the VCPU for the given entity. Measured in %.

- Virtual Memory (vMem)

The utilization of the VMEM for the given entity. Measured in Kilobytes (KB).

Virtual Machine

- Virtual CPU (vCPU)

The utilization of the VCPU for the given entity. Measured in %.

- Virtual Memory (vMem)

The utilization of the VMEM for the given entity. Measured in Kilobytes (KB).

MySQL

To manage MySQL databases, Turbonomic can connect to one or more database servers within a defined scope.

Prerequisites

- User Permissions are enabled on the MySQL Server. See [Enabling User Permissions on MySQL](#)

Adding a MySQL Database Target

You can add all matching targets within a given scope.

To add a database server as a target, you specify:

- Target ID

Name displayed in the Turbonomic UI

- Username

Username of the account Turbonomic uses to connect to the target.

- Password

Password of the account Turbonomic uses to connect to the target.

- Scope

A group of applications, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

If you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group can result in poor performance for discovery and monitoring. To target a larger number of VMs by scope, you should split them across smaller groups and set each group as the scope for a separate target.

- Port Number

The MySQL remote port. If blank, Turbonomic will use the MySQL default port of 3306.

- Full Validation

When selected, Turbonomic will require all database servers hosted on the VMs in the selected scope to be a valid target. If Turbonomic is unable to authenticate a database server in the scope, the target will not validate and data will not be collected.

Actions

Entity:	Actions:
Database Server	<ul style="list-style-type: none"> • Resize (Recommend, only) <ul style="list-style-type: none"> – DBMem – Connections
Virtual Machine	<ul style="list-style-type: none"> • Resize <ul style="list-style-type: none"> – Resize resource capacity <p>Change the capacity of a resource that is allocated for the VM. For example, a resize action might recommend increasing the VMem available to a VM. Before recommending this action, Turbonomic verifies that the VM's cluster can adequately support the new size. If the cluster is highly utilized, Turbonomic will recommend a move action, taking into consideration the capacity of the new cluster and compliance with existing placement policies.</p> <p>For hypervisor targets, Turbonomic can resize vCPU by changing the VM's socket or cores per socket count. For details, see VCPU Scaling Controls.</p> – Resize resource reservation <p>Change the amount of a resource that is reserved for a VM. For example, a VM could have an excess amount of memory reserved. That can cause memory congestion on the host — A resize action might recommend reducing the amount reserved, freeing up that resource and reducing congestion</p> – Resize resource limit <p>Change the limit that is set on the VM for a resource. For example, a VM could have a memory limit set on it. If the VM is experiencing memory shortage, an action that decreases or removes the limit could improve performance on that VM.</p> • Move <p>Move a VM due to:</p> <ul style="list-style-type: none"> – High resource utilization on VM or host – Excess IOPS or latency in VStorage – Workload placement violation – Underutilized host (move VM before suspending host) • Move VM Storage (Volume) <p>Move a VM's volume due to excess utilization of the current datastore, or for more efficient utilization of datastores in the environment.</p> • Reconfigure <p>Change a VM's configuration to comply with a policy.</p> <p>For hypervisor targets, Turbonomic can reconfigure VMs that violate vCPU scaling policies. For details, see VCPU Scaling Controls.</p> • Reconfigure VM Storage <p>Reconfigure overutilized storage resources by adding VStorage capacity. For underutilized storage resources, remove VStorage capacity.</p>

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Database Server

- DBMem

The memory utilized by the database, as a percentage of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM.

- Transactions

The utilization of the allocated transactions per second for the given virtual application
Measured in transactions per second

- Response Time

The utilization of the server's allocated response time
Measured in Milliseconds (ms)

- Connections

The utilization of the connection capacity. Only applicable to database servers
Measured in Connections

- Cache Hit Rate

The percentage of accesses that result in cache hits.
Measured in a percentage of hits vs total attempts (%)

Virtual Machine

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

- Virtual CPU (VCPU)

The utilization of the VCPU allocated to the hosting VM

- Virtual Storage (VStorage)

The utilization of the virtual storage capacity allocated for the VM

- Storage Access Operations Per Second (IOPS)

The utilization of IOPS allocated for the VStorage on the VM

- Latency

The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Enabling User Permissions on MySQL Server

Follow the following steps in order to enable appropriate user permissions on a MySQL Server.

1. Edit the MySQL server's configuration file.

You must edit the `.conf` file on the MySQL server to grant user permissions. Open a secure shell session on the server and edit the file. Depending on the platform your MySQL is running on, you'll find the file at different locations:

- Debian Linux:

`/etc/mysql/my.cnf`

- Red Hat Linux (Fedora or Centos):

`/etc/my.cnf`

- FreeBSD Linux:

You must create the file at `/var/db/mysql/my.cnf`

Open the file in an editor and find the section, `[mysqld]`. Then make the following changes:

- Comment out the line:

```
skip-networking
```

Commenting out this line enables remote connections over TCP/Is.

- Bind your MySQL server address

In the config file, add the line:

```
bind-address=<MySQL_IP_Address>
```

- Enable the collection of Transaction metrics

In the config file, add the line:

```
innodb_monitor_enable = trx_rw_commits, trx_nl_ro_commits, trx_ro_commits,
trx_rollbacks
```

For example, if your MySQL server has the address, `123.45.66.77`, then after you have bound the IP address and enabled Transaction metrics, the section of the `.conf` file should appear as follows:

```
[mysqld]

user          = mysql

pid-file      = /var/run/mysqld/mysqld.pid

socket        = /var/run/mysqld/mysqld.sock

port          = 3306

basedir       = /usr

datadir       = /var/lib/mysql

tmpdir        = /tmp

language      = /usr/share/mysql/English

bind-address  = 123.45.66.77

# skip-networking

# Uncomment the following line for MySQL versions 5.6+
innodb_monitor_enable = trx_rw_commits, trx_nl_ro_commits, trx_ro_commits, trx_rollbacks

....
```

When you are done, save the `.conf` file.

Note: Some MySQL installations use multiple configuration files. If a setting you made does not have the desired effect, make sure that a different configuration file is not overwriting the value.

2. Enable collection of Response Time metrics.

Execute the following command to log into to the MySQL server:

```
$mysql -u root -p mysql
```

Then execute the following SQL commands:

```
UPDATE performance_schema.setup_instruments SET ENABLED = 'YES' WHERE NAME LIKE 'statement/
sql%';
```

```
UPDATE performance_schema.setup_instruments SET TIMED = 'YES' WHERE NAME LIKE 'statement/
sql%';
```

Note:

If you want these changes to take effect each time you restart the MySQL server, add these statements to a file, and start the server with the `--init-file` option. For example, if you name the file `MyInit.txt`, then start the MySQL server with the following option:

```
--init-file=MyInit.txt
```

3. Give your Turbonomic server remote access to the database.

If you are not already logged into the MySQL server, execute the following command:

```
$mysql -u root -p mysql
```

Then execute the following commands:

Assume a user named `USER_NAME` with a password `PWD_STRING`. Then assume that your Turbonomic has an IP address of `10.10.123.45`. The following command grants privileges to that Turbonomic, if it connects with the specified user account:

```
GRANT SELECT ON performance_schema.* TO 'USER_NAME'@'10.10.123.45' IDENTIFIED BY
'PWD_STRING';
GRANT PROCESS ON *.* TO 'USER_NAME'@'10.10.123.45' IDENTIFIED BY 'PWD_STRING';
FLUSH PRIVILEGES;
```

Note that the `FLUSH PRIVILEGES` command causes MySQL to retain these settings upon restart.

When you're finished running these SQL commands, log out of MySQL.

Oracle

To connect to an Oracle database, you will:

- Add a Dynamic Performance view to the Oracle database
- Configure a service account on the database that Turbonomic can use to log on
- Find the Service Name and port for the database

Prerequisites

- User permissions that grant access to Turbonomic through a specific user account. See [Creating a Service User Account in Oracle](#).
- Dynamic Performance View (V\$) must be enabled. See "Adding a Dynamic Performance View", below.
- Access through the firewall to the Oracle database port that you specify for the Turbonomic target connection

Adding a Dynamic Performance View

In order to collect data from the Oracle database, Turbonomic uses the Dynamic Performance View (referred to as V\$). V\$ is not enabled by default. You must run a script to build the tables and views that are necessary to enable V\$. In some environments only the DBA has privileges to run this script.

To enable V\$:

- Open a secure shell session (ssh) on the database host as a system user or a user with the sysdba role

- In the shell session enter the following commands:

```
sqlplus /nolog
connect /as sysdba
CREATE USER My_Username IDENTIFIED BY My_Password container=all;
GRANT CONNECT TO My_Username container=all;
GRANT sysdba TO My_Username container=all;
```

Note:

If security or other practices prohibit assigning SYSDBA to this user, you can use the following command to provide access to all V\$ views:

```
GRANT select any dictionary TO My_Username;
```

This creates a user account named My_Username with full privileges to access the V\$ Dynamic Performance view.

Adding an Oracle Database to Turbonomic

You can add an individual database server as a target, or you can add all matching targets within a given scope.

To add a database server as a target, specify:

- **Target Name:**

The target name that will display in the Turbonomic user interface.

- **Username/Password:**

Valid client credentials for the database server. For Turbonomic to execute actions, the account must have administrator privileges. Also, you must have enabled user permissions to this user account, including remote access from the Turbonomic server.

- **Scope:**

A group of applications, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

If you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group can result in poor performance for discovery and monitoring. To target a larger number of VMs by scope, you should split them across smaller groups and set each group as the scope for a separate target.

Note:

All database servers in the scope must share the same service name, credentials, and port. For databases that have a different value for any of these, you must create a separate target using those values.

- **Oracle Port:**

The port that connects to the database. You must open the firewall on the database server to allow access through this port. For further information, see "Finding the Service Name and Port", below.

- **Oracle Service Name:**

The service name for the database that you are connecting to.

Finding the Service Name and Port

To specify an Oracle target, you must provide the service name and port that you want to connect to. To find the service name for your database:

- Open a secure shell session (ssh) on the database host as a system user or a user with the sysdba role
- In the shell session, enter the command, `lsnrctl status`
Find the line that has the string `PROTOCOL=tcp` and note the port number.
- In the shell session enter the following commands:

```
sqlplus /nolog
connect /as sysdba
SELECT SYS_CONTEXT('userenv', 'db_name') FROM dual;
```

Note the service name that displays as a result of these commands.

Actions

Entity:	Actions:
Database Server	<ul style="list-style-type: none"> • Resize (Recommend, only) <ul style="list-style-type: none"> – Connections – DBMem – Transaction Log <p>Resize actions based on the Transaction Log resource depend on support for vStorage in the underlying hypervisor technology. Because current versions of Hyper-V do not provide API support for vStorage, Turbonomic cannot support Transaction Log resize actions for database servers running on the Hyper-V platform.</p>
Virtual Machine	<ul style="list-style-type: none"> • Resize <ul style="list-style-type: none"> – Resize resource capacity <p>Change the capacity of a resource that is allocated for the VM. For example, a resize action might recommend increasing the VMem available to a VM. Before recommending this action, Turbonomic verifies that the VM's cluster can adequately support the new size. If the cluster is highly utilized, Turbonomic will recommend a move action, taking into consideration the capacity of the new cluster and compliance with existing placement policies.</p> <p>For hypervisor targets, Turbonomic can resize vCPU by changing the VM's socket or cores per socket count. For details, see VCPU Scaling Controls.</p> – Resize resource reservation <p>Change the amount of a resource that is reserved for a VM. For example, a VM could have an excess amount of memory reserved. That can cause memory congestion on the host — A resize action might recommend reducing the amount reserved, freeing up that resource and reducing congestion</p> – Resize resource limit <p>Change the limit that is set on the VM for a resource. For example, a VM could have a memory limit set on it. If the VM is experiencing memory shortage, an action that decreases or removes the limit could improve performance on that VM.</p> • Move <p>Move a VM due to:</p> <ul style="list-style-type: none"> – High resource utilization on VM or host – Excess IOPS or latency in VStorage – Workload placement violation

Entity:	Actions:
	<ul style="list-style-type: none"> – Underutilized host (move VM before suspending host) • Move VM Storage (Volume) Move a VM's volume due to excess utilization of the current datastore, or for more efficient utilization of datastores in the environment. • Reconfigure Change a VM's configuration to comply with a policy. For hypervisor targets, Turbonomic can reconfigure VMs that violate vCPU scaling policies. For details, see VCPU Scaling Controls. • Reconfigure VM Storage Reconfigure overutilized storage resources by adding VStorage capacity. For underutilized storage resources, remove VStorage capacity.

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Database Server

- DBMem
The memory utilized by the database, as a of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM
- Transactions
The utilization of the allocated transactions per second for the given virtual application
Measured in transactions per second
- Response Time
The utilization of the server's allocated response time
Measured in Milliseconds (ms)
- Connections
The utilization of the connection capacity. Only applicable to database servers
Measured in Connections
- TransactionLog
The utilization of the server's capacity for storage devoted to transaction logs
Measured in Kilobytes (KB)
- Cache Hit Rate
The percentage of accesses that result in cache hits.
Measured in a percentage of hits vs total attempts (%)

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)

The utilization of the VCPU allocated to the hosting VM

Measured in Megahertz (MHz)

- Virtual Storage (VStorage)

The utilization of the virtual storage capacity allocated for the VM

Measured in Kilobytes (KB)

- Storage Access Operations Per Second (IOPS)

The utilization of IOPS allocated for the VStorage on the VM

Measured in IOPS

- Latency

The utilization of latency allocated for the VStorage on the VM

Measured in milliseconds (ms)

Creating a Service User Account in Oracle

To collect data from the Oracle database, Turbonomic requires a service account that has privileges to access the V\$ Dynamic Performance view. To create this account:

- Open a secure shell session (ssh) on the database host as a system user or a user with the sysdba role
- In the shell session enter the following commands:

```
sqlplus /nolog
```

```
connect /as sysdba
```

```
CREATE USER My_username IDENTIFIED BY My_Password container=all;
```

```
GRANT CONNECT TO My_username container=all;
```

```
GRANT sysdba TO My_username container=all;
```

This creates a user account named My_username with full privileges to access the V\$ Dynamic Performance view.

Note:

The above example uses a fictitious username. To comply with Oracle 12C norms, the username should include a prefix of c##.

Some enterprises don't allow accounts with sysdba access. IBM recommends using sysdba, according to the Oracle documentation. However, you can work with your Oracle DBA staff to provide read access to the following views, which are the ones that Turbonomic needs:

- V\$INSTANCE
- V\$LOG
- V\$LOGFILE
- V\$PARAMETER
- V\$PGASTAT
- V\$RESOURCE_LIMIT
- V\$SGASTAT
- V\$SYS_TIME_MODEL
- V\$SYSMETRIC
- V\$SYSSTAT

SQL Server

Turbonomic supports the following versions of this target:

Microsoft SQL Server 2012, 2014, 2016, 2017, and 2019

Note:

SQL Server clusters are not supported by this version of Turbonomic.

Prerequisites

- A user account with SQL permissions including `Connect SQL` and `View Server State` on the database
- The following services must be running, and set to enabled:
 - Net.Tcp Listener Adapter
 - Net.Tcp Port Sharing Service
- TCP/IP is enabled on the port used for Turbonomic discovery
- To enable dynamic port discovery, the port used by the SQL Browser Service

Creating a Service User Account

The user account that Turbonomic uses for its service login must include the following:

- The account must exist in the Security folder within the SQL Server Object Explorer, with the following properties:
 - Enable **SQL Server Authentication**
 - Disable **Enforce password policy**
- The account's security properties must include:
 - Permission to connect to the database through SQL
 - Permission to view the server state

Adding a SQL Server Database to Turbonomic

To add an SQL Server target, you add all matching databases within a given scope.

To add a database server as a target, you specify:

- Target Name
Name displayed in the Turbonomic UI
- Username
Username for the account. This username must not include the AD domain
- Password
Password for the account. This username must not include the AD domain
- Scope

A group of applications, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

If you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group can result in poor performance for discovery and monitoring. To target a larger

number of VMs by scope, you should split them across smaller groups and set each group as the scope for a separate target.

- **Browsing Service Port**

The port used to communicate with the browsing service. Turbonomic will obtain the SQLServer port for each instance running on each VM in the scope.

- **SQLServer Port**

The SQL remote port. Turbonomic will use this port if there is no browsing service port specified, or if the browsing service is not available during discovery.

Note:

Turbonomic will connect to the port specified for the SQL browsing service first. If that connection fails, Turbonomic will connect using the SQLServer Port.

- **Domain Name**

The Active Directory domain used by Turbonomic in conjunction with the Username for authentication. Leave blank for local accounts.

- **Full Validation**

When selected, Turbonomic will require all database servers hosted on the VMs in the selected scope to be a valid target. If Turbonomic is unable to authenticate a database server in the scope, the target will not validate and data will not be collected.

For additional information about adding SQL Server targets, see the Green Circle article, "[How to Target SQL Servers \(5.4 and later\)](#)".

Actions

Turbonomic recommends actions for the application supply chain as follows.

Applications

Without separate targets to discover Guest OS Processes or Application Servers, Turbonomic does not generate actions on applications. Instead, it generates resize actions on the host VMs. For on-prem environments, if host utilization is high enough on the physical machine running the application VM, Turbonomic can also recommend provisioning a new host.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
- Suspend VM
- Provision VM

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Database Server

- DBMem

The memory utilized by the database, as a percentage of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM.

- Transactions
The utilization of the allocated transactions per second for the given virtual application
Measured in transactions per second
- Response Time
The utilization of the server's allocated response time
Measured in Milliseconds (ms)
- Connections
The utilization of the connection capacity. Only applicable to database servers
Measured in Connections
- TransactionLog
The utilization of the server's capacity for storage devoted to transaction logs
Measured in Kilobytes (KB)
- Cache Hit Rate
The percentage of accesses that result in cache hits.
Measured in a percentage of hits vs total attempts (%)

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

JBoss

Turbonomic supports connecting to JBoss targets running in these operation modes:

- Managed Domain
A collection of JBoss servers in a domain, with a single Domain Controller process acting as the central management control point. In this case, the VM that hosts the Domain Controller will be the target. You configure a Domain Controller via the `domain-controller` entry in the `host.xml` file on the JBoss machine.
- Standalone
A single JBoss server. The VM that hosts the server is the target.

Prerequisites

- The target VM is properly configured as Domain Controller or standalone, depending on the operation mode.

- Turbonomic discovers JBoss servers that are running on VMs, or on containers that are deployed on VMs. To set the target for a JBoss server, you must have first discovered the hosting VM through a hypervisor target.

For information about hypervisor targets, see [Hypervisor Targets](#).

- Turbonomic monitors the Threads resource in application servers to track utilization of thread pool capacity. To monitor threads in JBoss, each JBoss server must define a thread pool in its configuration files. For instructions on specifying thread pools, see the JBoss documentation.
- JBoss supports Role-Based Access Control (RBAC) as a way to specify a set of permissions for user accounts.

JBoss disables RBAC by default. If you enable RBAC, Turbonomic requires the Monitor role for the target JBoss account in order to discover JBoss servers.

Adding a JBoss Target

You can add an individual JBoss server as a target, or you can add all matching targets within a given scope.

To add a server as a target, specify:

- Target Name

Name displayed in the Turbonomic user interface

- Username

The username for a JBoss account that has a role with the necessary permissions.

- Password

The password for the JBoss account that you will use.

- Scope

A group of JBoss servers, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

After you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group may result in delays in discovery and monitoring. If larger numbers of VMs are to be targeted, the recommendation is to split them across smaller groups in multiple targets.

- JBoss Webservice port

The port for connections to the JBoss server. The default port for HTTP access is 9990.

- Full Validation

When enabled, Turbonomic will require all JBoss servers hosted on the VMs in the selected scope to be valid targets. If Turbonomic is unable to authenticate a JBoss server in the scope, the target will not validate and data will not be collected.

- Secure Connection

When enabled, Turbonomic will connect to JBoss servers via HTTPS. Be sure that the required certificate has been configured for use on the host.

- Proxy Information

Specify proxy information only if you connect to a JBoss instance via proxy.

- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the AppDynamics instance via a proxy.

- Proxy Port
The port to use with the proxy specified above. By default, this is 8080.
- Proxy Username
The username to use with the proxy specified above.
- Proxy Password
The password to use with the proxy specified above.
- Secure Proxy Connection
When checked, Turbonomic will connect to the proxy via HTTPS.

Application Component Names

Turbonomic displays discovered JBoss servers in the user interface. These names indicate whether they're standalone or in a managed domain.

The name is divided into three sections:

- Domain Controller name or “STANDALONE”
- The server name
- The name or IP address of the VM hosting the JBoss server

For example:

STANDALONE:acm-jboss73 [ACM-JBoss7.3-171.47]

Actions

Application Component

- Resize Heap
Recommendation only.
- Resize Thread Pool
Recommendation only.
- Resize Connection Capacity
Recommendation only.
- Suspend VM
This action can only be executed by a VM hosted in a vCenter environment. Applications running on other hypervisors will see only a recommendation.
- Provision VM
Recommendation only.

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Application Component

- Transactions
The utilization of the allocated transactions per second for the given application.
- Heap
The utilization of the application server's heap.
- Response Time
The utilization of the server's allocated response time.

- Threads
The utilization of the server's thread capacity.
- Connection
The utilization of the connection capacity. Only applicable to database servers.
- Remaining GC Capacity
The percentage of server uptime spent not performing garbage collection.

Apache Tomcat

Turbonomic supports connecting to individual Tomcat targets. Turbonomic connects to the Tomcat process as a remote client via remote JMX access. Target configuration includes the port used by the JMX/RMI registry.

Prerequisites

- A valid JMX user account for the Tomcat server.
If Tomcat security is enabled, this must be a Tomcat JMX user with a `readonly` role.
- Tomcat should run on JVM version 7 or 8
- For VMware environments, VMware Tools must be installed on the VM that hosts the Tomcat server. For Hyper-V environments, Hyper-V Integration Services must be installed.
This ensures that the VM hosting the Tomcat server can get its IP address.
- Remote JMX access is enabled through a port that is opened to the firewall.
- Discovered infrastructure.

Turbonomic discovers Tomcat servers that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.

To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for Tomcat applications.

- For information about container targets, see [Kubernetes Platform Targets](#)
- For information about hypervisor targets, see [Hypervisor Targets](#)

Configuring JMX Remote Access

Turbonomic monitors and controls the Tomcat server via JMX Remote access. You must configure a JMX Remote port.

Note that to work with a firewall you should also set the RMI Server port — If you don't set an RMI port, then JMX sets an arbitrary *ephemeral port*, and you can't guarantee that the port will be open to your firewall.

There are two ways to set JMX Remote port on Linux platforms:

- Ports specified as system properties

You can set the port via the system property, `com.sun.management.jmxremote.port`. For example:

```
com.sun.management.jmxremote.port=8050
```

A common way to set this property is to declare it in the `CATALINA_OPTS` system variable — You can set this in the `setenv.sh` script. For example:

```
CATALINA_OPTS="$CATALINA_OPTS
```

```
-Dcom.sun.management.jmxremote
```

```
-Dcom.sun.management.jmxremote.port=8050"
```

```
export CATALINA_OPTS
```

Note that this sets the JMX Remote port, but it does not set the RMI Server port — Tomcat startup will specify an ephemeral port for the RMI server.

- Ports specified in a JMX Remote Lifecycle Listener

This listener component fixes the ports used by the JMX/RMI Server. When you configure the listener, you specify both the JMX Remote port and the RMI Server port. This is the preferred method when working with a firewall. For more information, see the Apache Tomcat documentation.

On Windows, the typical installation is with Tomcat as a service. There are two ways to set the JMX Remote port:

- Via `setenv.bat`

Add the property to the `CATALINA_OPTS` environment variable:

```
set "CATALINA_OPTS=%CATALINA_OPTS% -Dcom.sun.management.jmxremote.port=8050"
```

- Use the Tomcat configuration utility (`tomcat7w` or `tomcat8w`)

Set the port with the following command:

```
-Dcom.sun.management.jmxremote.port=8050"
```

To discover the JMX port that is set to an already running Tomcat, you can look in the following locations:

- For Linux platforms, look in the configuration files — Either:
 - `setenv.sh` — Assuming you configured the port by adding it to the `CATALINA_OPTS` environment variable
 - `$CATALINA_HOME/conf/server.xml` — Assuming you configured a JMX Remote Lifecycle Listener in this file
- For Windows platforms, look in:
 - `setenv.bat` — Assuming you configured the port by adding it to the `CATALINA_OPTS` environment variable
 - The Windows registry — Assuming you installed Tomcat as a Windows service using the Tomcat Configuration utility

Adding a Tomcat Target

You can add an individual Tomcat server as a target, or you can add all matching servers within a given scope.

To add a server as a target, specify:

- Target Name
Name displayed in the Turbonomic UI
- Username
Username of an account with the Admin role
- Password
Password of an account with the Admin role
- Scope

A group of applications, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

If you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group can result in poor performance for discovery and monitoring. To target a larger number of VMs by scope, you should split them across smaller groups and set each group as the scope for a separate target.

- **JMX Remote Port**

A JMX port that is set to an already running Tomcat process.

- **Full Validation**

When selected, Turbonomic will require all database servers hosted on the VMs in the selected scope to be a valid target. If Turbonomic is unable to authenticate a database server in the scope, the target will not validate and data will not be collected.

- **Proxy Host**

The address of the proxy used for this target. Only fill out proxy information if you connect to the AppDynamics instance via a proxy.

- **Proxy Port**

The port to use with the proxy specified above. By default, this is 8080.

- **Proxy Username**

The username to use with the proxy specified above.

- **Proxy Password**

The password to use with the proxy specified above.

- **Secure Proxy Connection**

When checked, Turbonomic will connect to the proxy via HTTPS.

Actions

Turbonomic recommends actions for the application supply chain as follows.

Application Component (Tomcat Application)

- **Resize Heap**
Recommendation only.
- **Resize Thread Pool**
Recommendation only.
- **Resize Connection Capacity**
Recommendation only.

Virtual Machines

- **Provision additional resources (VMem, VCPU)**
- **Move Virtual Machine**
- **Move Virtual Machine Storage**
- **Reconfigure Storage**
- **Reconfigure Virtual Machine**
- **Suspend VM**
- **Provision VM**

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Application Component

- Virtual Memory (VMem)
The utilization of the VMem consumed from the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
The utilization of VCPU consumed from the hosting VM
Measured in Megahertz (MHz)
- Transactions
The utilization of the allocated transactions per second for the given application
Measured in transactions per second
- Heap
The utilization of the application server's heap
Measured in Kilobytes (KB)
- Response Time
The utilization of the server's allocated response time
Measured in Milliseconds (ms)
- Threads
The utilization of the server's thread capacity
Measured in Threads
- Connection
The utilization of the connection capacity. Only applicable to database servers
Measured in Connections
- Remaining GC Capacity
The percentage of server uptime spent not performing garbage collection
Measured in uptime (%)

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)

JVM Application

Turbonomic supports connecting to individual JVM Applications as targets. Turbonomic connects to the JVM process as a remote client via remote JMX access. Target configuration includes the port used by the JMX/RMI registry.

Prerequisites

- A valid JMX user account for the JVM application

If JMX security is enabled this must be a JMX user with a `readonly` role

- The application should run on JVM version 6.0 or higher
- For VMware environments, VMware Tools must be installed on the VM that hosts the application

This ensures that the VM hosting the application can get the application's IP address

- Remote JMX access is enabled through a port that is opened to the firewall
- Discovered infrastructure

Turbonomic discovers JVM applications that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.

To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for JVM applications.

- For information about container targets, see [Kubernetes Platform Targets](#)
- For information about hypervisor targets, see [Hypervisor Targets](#)

Configuring JMX Remote Access

Turbonomic monitors and controls JVM applications via JMX Remote access. You must configure a JMX Remote port.

Note that to work with a firewall you should also set the RMI Server port — If you don't set an RMI port, then JMX sets an arbitrary *ephemeral port*, and you can't guarantee that the port will be open to your firewall.

To set the JMX Remote port, pass in the port at the command line when you start your application. For example, to set the port to 8090, start your application with the following options:

```
-Dcom.sun.management.jmxremote -Dcom.sun.management.jmxremote.port=8090
```

Adding JVM Application Targets

When you configure JVM targets, you declare a given scope and add all matching applications within that given scope. To do this, specify:

- **Scope:**

A group of applications, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

If you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group can result in poor performance for discovery and monitoring. To target a larger number of VMs by scope, you should split them across smaller groups and set each group as the scope for a separate target.

- **Port Number:** The JMX Remote port
- **Username/Password:** Credentials for a user account with an Admin role

The credentials you provide must match the credentials you specify for JMX login configuration when you start up the application.

If you disable authentication on the application, then you must still provide arbitrary values for **Username** and **Password**. To disable JMX authentication, use the following flags in the command line as you start the application:

```
-Dcom.sun.management.jmxremote.authenticate=false
```

```
-Dcom.sun.management.jmxremote.ssl=false
```

Multiple JVM Targets On Single VM

Note that you can specify targets with different ports, but that run on the same VM (use the same IP address). You can also specify targets via the same scope, but with different ports — This is another way to assign applications running on the same VM to different ports. To do this:

To do this, add the targets in two separate steps. For example, assume you want to add two JVM application targets, and they both run on the VM at 10.10.123.45. One application is on port 123, and the other application is on port 456. To specify these two targets:

- Specify the first target with the following parameters:

- Scope: VMs_myCluster.mycorp.com
- Port number: 123
- Username: AppUser
- Password: *****

Then click **ADD**.

- Specify the second target with the following parameters:

- Scope: VMs_myCluster.mycorp.com
- Port number: 456
- Username: OtherAppUser
- Password: *****

Then click **ADD**.

Actions

Turbonomic recommends actions for the application supply chain as follows.

Application Component (JVM Application)

- Resize Heap
Recommendation only.
- Resize Thread Pool
Recommendation only.
- Resize Connection Capacity
Recommendation only.
- Suspend VM
This action can only be executed by a VM hosted in a vCenter environment. Applications running on other hypervisors will see only a recommendation.
- Provision VM
Recommendation only.

Virtual Machines

- Provision additional resources (VMem, VCPU)

- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
- Suspend VM
- Provision VM

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Application Component (JVM Application)

- Heap
The utilization of the application server's heap
Measured in Kilobytes (KB)
- Remaining GC Capacity
The percentage of server uptime spent garbage collecting. Available when the JVM profiler is enabled.
Measured in percentage of uptime (%)

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)

Oracle WebLogic

The typical WebLogic deployment is a managed domain with one Administration Server that provides a single point of entry for administration and management of the domain. The domain can include other WebLogic Servers which are the Managed Servers. You set the WebLogic Administration Server as a Turbonomic target.

For a standalone WebLogic deployment, the single server acts as its own Administration Server — You can set the standalone server as a Turbonomic target.

WebLogic deployments can include clusters to distribute workload across multiple WebLogic servers. Turbonomic recommended actions respect the cluster architecture. For example, if you have enabled horizontal scaling for your WebLogic servers, then Turbonomic can recommend provisioning new servers for a given cluster.

Prerequisites

- A service user account.
To execute actions the service account must have an Admin role. For read-only monitoring and analysis, you can set the target with a more restricted role, but then you will have to execute all recommended actions manually, through the WebLogic interface.
- WebLogic requires both the local and remote ends of the connection be resolvable by DNS. The Turbonomic IP address and all WebLogic server IP addresses must be resolvable by your local DNS server.

- Discovered infrastructure

Turbonomic discovers WebLogic servers that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.

To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for WebLogic applications.

- For information about container targets, see [Kubernetes Platform Targets](#)
- For information about hypervisor targets, see [Hypervisor Targets](#)

Finding the T3 Listen Port

To configure a WebLogic target, you need to know the port that the server listens on for administrative communications. Launch the WebLogic Administration Console:

- Navigate to Domain Structure and display the domain you're interested in
- Navigate to **Environment > Servers** and select the Domain Administration Server you're setting as a target

The console displays configuration information for the server, including the T3 listen port.

Adding a WebLogic Target

You can add one or more WebLogic targets in a given scope, including both standalone servers and domain managers.

To add a this target, specify:

- Target Name
Name displayed in the Turbonomic UI
- Username
Username of an account with the Admin role
- Password
Password of an account with the Admin role
- Scope

A group of applications, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

If you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group can result in poor performance for discovery and monitoring. To target a larger number of VMs by scope, you should split them across smaller groups and set each group as the scope for a separate target.

- Port Number
The WebLogic remote port
- Full Validation

When selected, Turbonomic will require all database servers hosted on the VMs in the selected scope to be a valid target. If Turbonomic is unable to authenticate a database server in the scope, the target will not validate and data will not be collected.

Actions

Turbonomic recommends actions for the application server supply chain as follows:

Service

Turbonomic does not recommend actions to perform on the service itself, but it does recommend actions to perform on the application components and hosting VMs. For example, assume a service that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new application component to run another instance of the database application, and bind it to the service. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it.

Application Component

- Resize Heap

This action can only be executed by Turbonomic when running in a domain controller. Standalone applications will see only a recommendation.

- Resize Connection Capacity

Recommendation only.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Reconfigure Storage
- Suspend VM

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Service

- Transactions

The utilization of the allocated transactions per second for the given service

Measured in transactions per second

Application Component

- Virtual Memory (VMem)

The utilization of the VMem consumed from the hosting VM

Measured in Kilobytes (KB)

- Virtual CPU (VCPU)

The utilization of VCPU consumed from the hosting VM

Measured in Megahertz (MHz)

- Transactions

The utilization of the allocated transactions per second for the given application

Measured in transactions per second

- Heap

The utilization of the application server's heap

Measured in Kilobytes (KB)

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Threads

The utilization of the server's thread capacity

Measured in Threads

- Connection

The utilization of the connection capacity. Only applicable to database servers

Measured in Connections

- Remaining GC Capacity

The percentage of server uptime spent not performing garbage collection

Measured in uptime (%)

Virtual Machine

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

Measured in Kilobytes (KB)

- Virtual CPU (VCPU)

The utilization of the VCPU allocated to the hosting VM

Measured in Megahertz (MHz)

IBM WebSphere

The typical WebSphere deployment is a cell of WebSphere servers, controlled by a Deployment Manager. A cell makes up a managed domain that incorporates multiple VMS that host managed application servers. The Deployment Manager is a WebSphere instance that provides a single point of entry for the managed domain.

Note:

When adding a WebSphere Deployment Manager as a target, you must ensure that the name of each WebSphere node is resolvable to an IP address by the Turbonomic instance.

You may need to make changes to your DNS or the file `/etc/resolv.conf` on the Turbonomic instance to make it aware of the domain names in use in your environment.

To configure the WebSphere installation, you can use the WebSphere Integrated Solutions Console. This is a client that exposes configuration settings including the SOAP port and the PMI settings.

To manage the servers in an installation, WebSphere uses the Performance Monitoring Infrastructure (PMI). Each WebSphere server runs a PMI service that collects performance data from the various application server components. Turbonomic uses PMI for monitoring and control of the WebSphere installation.

Prerequisites

- The PMI service set to monitor at the Basic level or greater
- A service user account

To execute actions the service account must have an Administrator role. For read-only monitoring and analysis, you can set the target with a more restricted role (Monitor), but then you will have to execute all recommended actions manually, through the WebSphere interface.

- Discovered infrastructure

Turbonomic discovers WebSphere servers that are running on VMs or containers. The hosting VM or container must already be in your Turbonomic inventory.

To set the target for a server running on a VM, you must have first discovered the hosting VM through a Hypervisor target. To set the target for a server running in a container, you must have configured container discovery for WebSphere applications.

- For information about hypervisor targets, see [Kubernetes Platform Targets](#)
- For information about container targets, see [Hypervisor Targets](#)

Finding the SOAP Connector Address

To configure a WebSphere target, you need to know the port that the server listens on for administrative communications. Launch the WebSphere Administration Console:

- Navigate to System **Administration > Deployment Manager**
- Under **Additional Properties**, click **Ports**

The entry for SOAP_CONNECTOR_ADDRESS gives the currently set port number.

Adding a WebSphere Target

You can add an individual WebLogic server as a target, or you can add all matching targets within a given scope.

To add a server as a target, specify:

- Target Name
Name displayed in the Turbonomic UI
- Username
Username of an account with the Admin role
- Password
Password of an account with the Admin role
- Scope

A group of applications, stitched to the underlying VMs when the VMs are discovered as part of a separate Turbonomic target.

If you set the target scope, Turbonomic scans each VM within that group or cluster and tries to connect to the target over the specified port. Turbonomic adds any instances of the target it finds as entities from which metrics are retrieved.

The maximum supported size of the group is 500 VMs, and the recommended size is 250 VMs. Adding more VMs to the group can result in poor performance for discovery and monitoring. To target a larger number of VMs by scope, you should split them across smaller groups and set each group as the scope for a separate target.

- Port Number
The WebSphere remote port
- Full Validation

When selected, Turbonomic will require all database servers hosted on the VMs in the selected scope to be a valid target. If Turbonomic is unable to authenticate a database server in the scope, the target will not validate and data will not be collected.

Actions

Turbonomic recommends actions for the application server supply chain as follows:

Service

Turbonomic does not recommend actions to perform on the service itself, but it does recommend actions to perform on the application components and hosting VMs. For example, assume a service that manages three SQL databases. If a surge in requests degrades performance across all three databases, then Turbonomic can start a new application component to run another instance of the database application, and bind it to the service. On the other hand, if SQL requests drop off so that the load balancer only forwards requests to two of the databases, Turbonomic can suspend the dormant database and unbind it.

Application Component

- Resize Heap

This action can only be executed by Turbonomic when running in a domain controller. Standalone applications will see only a recommendation.

- Resize Connection Capacity

Recommendation only.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Reconfigure Storage
- Suspend VM

Monitored Resources

Turbonomic monitors the following resources for the application server supply chain:

Service

- Transactions

The utilization of the allocated transactions per second for the given service

Measured in transactions per second

Application Component

- Virtual Memory (VMem)

The utilization of the VMem consumed from the hosting VM

Measured in Kilobytes (KB)

- Virtual CPU (VCPU)

The utilization of VCPU consumed from the hosting VM

Measured in Megahertz (MHz)

- Transactions

The utilization of the allocated transactions per second for the given application

Measured in transactions per second

- Heap

The utilization of the application server's heap

Measured in Kilobytes (KB)

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- **Threads**
The utilization of the server's thread capacity
Measured in Threads
- **Connection**
The utilization of the connection capacity. Only applicable to database servers
Measured in Connections
- **Remaining GC Capacity**
The percentage of server uptime spent not performing garbage collection
Measured in uptime (%)

Virtual Machine

- **Virtual Memory (VMem)**
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- **Virtual CPU (VCPU)**
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)

Instana

Turbonomic supports discovery of applications that are managed by the Instana platform. Turbonomic includes the discovered information about these applications in its calculations for environment health.

Note:

For Kubernetes environments, Turbonomic stitches NewRelic, AppDynamics, Instana, and Dynatrace containerized application components into the supply chain to provide a unified view of your applications. For more information, see [Cloud Native Targets](#).

Prerequisites

- Instana, release-209 or later
- A self-hosted or SaaS Instana instance
This instance must be configured to monitor applications running in your environment.
- Virtual machines and/or containers that are running applications managed by Instana
For Turbonomic to discover applications through Instana, the applications must be running on virtual machines or in Kubernetes containers located in your environment. Also, these entities must be managed by Turbonomic hypervisor, public cloud, or Kubernetes targets.
- A valid Instana API token
This must be an API token created with the default permissions.

Entity Mapping

After validating the new target, Turbonomic discovers the connected entities, and adds them to the supply chain. This table maps terms from Instana to the types of entities Turbonomic creates in the supply chain:

Instana Term	Turbonomic Entity
Application	Business Application
Endpoint	Business Transaction

Instana Term	Turbonomic Entity
Service	Service
Process	Application Component
Docker / Crio Container	Container
Host	Virtual Machine

Instana Permissions

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none"> Default <p>Turbonomic uses the default API Token for monitoring access.</p>

Adding an Instana Target

Note:

It is possible to monitor certain applications or database servers with both Instana and another Turbonomic target. You should avoid such a configuration because it can cause Turbonomic to generate duplicate entities in the supply chain.

If you monitor an application via an Instana server, and you configure that Instana server as a Turbonomic target, then be sure you have not configured a separate application target in Turbonomic for that same application.

To add an Instana server instance as a target, specify:

- Hostname or IP Address

The host name or IP of the Instana server.

- API Token

The Instana API Token.

- Collect Virtual Machine Metrics

Whether to collect VM metrics from this target. When **Collect Virtual Machine Metrics** is turned on, Turbonomic uses the VM metrics it collects from this target, instead of the matching data it collects from the underlying VM's hypervisor or cloud provider target.

- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the Instana server via a proxy.

- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.

- Proxy Username

The username for the account to log into the proxy specified above.

- Proxy Password

The password to use with the proxy specified above.

- Secure Proxy Connection

When checked, Turbonomic will connect to the proxy over HTTPS.

Actions

Turbonomic does not recommend actions for Instana business applications, business transactions, or services. However, it considers resource utilization by these applications when recommending actions for the underlying virtual machines or containers. Turbonomic propagates this underlying information upward in the supply chain to show the impact infrastructure risks can have on the business applications, transactions, and services.

In addition, Turbonomic recommends actions for:

Application Component

- Resize Heap
Recommendation only.

Monitored Resources

Note:

The exact resources monitored will differ based on application type. This list includes all resources you may see.

Turbonomic monitors the following resources for the Instana supply chain:

Business Application

- Response Time
The utilization of the server's allocated response time
Measured in Milliseconds (ms)
- Transactions
The utilization of the allocated transactions per second for the given entity
Measured in transactions per second

Business Transaction

- Response Time
The utilization of the server's allocated response time
Measured in Milliseconds (ms)
- Transactions
The utilization of the allocated transactions per second for the given business transaction
Measured in transactions per second

Service

- Response Time
The utilization of the server's allocated response time
Measured in Milliseconds (ms)
- Transactions
The utilization of the allocated transactions per second for the given entity
Measured in transactions per second

Application Component

- Virtual CPU (vCPU)
The utilization of the VCPU for the given entity. Measured in %.
- Virtual Memory (vMem)

The utilization of the VMEM for the given entity. Measured in Kilobytes (KB).

- Remaining Garbage Collection Capacity

The percentage of server uptime spent not performing garbage collection
Measured in uptime (%)

Note:

This commodity is for Java applications, only.

- Heap

The utilization of the application server's heap
Measured in Kilobytes (KB)

Note:

This commodity is collected for Java applications only.

Container

- VMem

The of memory capacity the container utilizes
Measured in Megabytes (MB)

Note: VMem is only collected for Docker containers.

Virtual Machine

- Virtual CPU (vCPU)

The utilization of the VCPU for the given entity. Measured in %.

- Virtual Memory (vMem)

The utilization of the VMEM for the given entity. Measured in Kilobytes (KB).

Cloud Native Targets

Containers support separation of concerns in a way similar to virtual machines, but allow greater flexibility and use far less overhead. Containers can be deployed singly (uncommon) or within a cluster containing multiple nodes. A single container can implement a complete application, or one container can implement a single process that contributes to a larger, distributed application.

To support cloud native environments, Turbonomic targets Kubernetes clusters. Turbonomic supports target clusters managed on Kubernetes v1.8 or higher, whether the clusters are managed directly via kubeadm, or via other platforms including:

- OpenShift
- Pivotal Kubernetes Service
- Amazon Elastic Kubernetes Service (EKS)
- Azure Kubernetes Service (AKS)
- Cisco Container Platform (CCP)
- Google Kubernetes Engine (GKE)

With Cloud Native targets, Turbonomic discovers entities related to container platforms in your environment. Discovery can also stitch the container cluster entities together with managed applications. For example, discovery can show the full application stack if your container environment includes applications managed by the following technologies, and you have added them as targets to Turbonomic:

- [Cisco AppDynamics](#)
- [Instana](#)

- [Dynatrace](#)
- [New Relic](#)

Prerequisites

- Running Kubernetes 1.8+ Cluster

Adding a Kubernetes Target

Detailed steps for adding a Kubernetes target can be found on the [KubeTurbo Wiki](#).

Supply Chain

Turbonomic adds several entities to the supply chain: Services, Containers, Container Pods, Container Specs, Workload Controllers, Namespaces, Volumes, and VirtualMachines. Each entity represents key components of your containerized application running in Kubernetes.

Actions

Turbonomic recommends actions for the Kubernetes container platform supply chain as follows.

Service

None

No actions are recommended at this level of the supply chain. Instead, actions that affect the service are generated and executed on underlying entities.

Application Component

Suspend

Application components are suspended due to a node (virtual machine) suspension

APM Actions

Application components may also receive other actions as part of APM integration related to those use cases. For example, a `Resize Heap` action from an underlying AppDynamics integration. See the Target Configuration Guide documentation for the appropriate technology to discover what actions may be available.

Container

Resize Container Up/Down

With `Merged Actions` enabled, individual Container actions will be recommend only and the resize will be reflected as an action on the Workload Controller entity.

Suspend

Containers are suspended due to a node (virtual machine) suspension

Container Pod

Move Pod

Pods will be moved across nodes (Virtual Machines).

Suspend

Container Pods are suspended due to a node (virtual machine) suspension

Container Spec

None

No actions are recommended at this level of the supply chain. This entity maintains the history of all replicas, or instances of pods for this container specification.

Workload Controller

Resize Container

With `Merged Actions` enabled, this is a single resize action representing all resize actions for containers associated to a specific workload controller.

Namespace

None

No actions are recommended at this level of the supply chain. Namespace Quotas are constraints to container resizing actions.

Virtual Machine (Node)

Provision Additional Resources

The following resources may be provisioned:

- VMem
- VCPU
- VMem Requests
- VCPU Requests
- Number of Consumers

Suspend

Nodes (virtual machines) may be suspended.

Infrastructure-dependent Actions

Depending on the technology the node is stitched to for underlying infrastructure, there may be additional actions:

On-prem VMware:

- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine

Volume

None

No actions are recommended at this level of the supply chain. These entities will be stitched to public cloud storage volumes.

Monitored Resources

Turbonomic monitors the following resources for the Kubernetes container platform supply chain:

Service

Response Time

Response time of the service, measured in ms.

This commodity is populated via APM or DIF integrations.

Transactions

Transaction utilization, measured in transactions per second.

This commodity is populated via APM or DIF integrations.

Application Component

Various Commodities

The commodities monitored and the values received for those commodities at the application component level is dependent on the APM integration used. See the Target Configuration Guide documentation for the appropriate technology to discover what data will be reported.

Container

VMem

The virtual memory utilized by the container against the memory limit (if no limit is set, then node capacity is used). Measured in Megabytes (MB)

VMem Request

If applicable, the virtual memory utilized by the container against the memory request. Measured in Megabytes (MB)

VCPU

The virtual CPU utilized by the container against the CPU limit (if no limit is set, then node capacity is used). Measured in millicores (mCores)

VCPU Request

If applicable, the virtual CPU utilized by the container against the CPU request. Measured in millicores (mCores)

VCPU Throttling

The throttling of container vCPU that could impact response time, expressed as the percentage of throttling for all containers associated with a Container Spec. In the Capacity and Usage chart for containers, *used* and *utilization* values reflect the actual throttling percentage, while *capacity* value is always 100%.

Container Pod**VMem**

The virtual memory utilized by the pod against the node physical capacity. Measured in Megabytes (MB)

VCPU

The virtual CPU utilized by the pod against the node physical capacity. Measured in millicores (mCores)

VMem Request

The virtual memory request allocated by the pod against the node allocatable capacity. Measured in Megabytes (MB)

VCPU Request

The virtual CPU request allocated by the pod against the node allocatable capacity. Measured in millicores (mCores)

VMem Request Quota

If applicable, The amount of virtual memory request the pod has allocated against the namespace quota. Measured in Megabytes (MB)

VCPU Request Quota

If applicable, The amount of virtual CPU request the pod has allocated against the namespace quota. Measured in millicores (mCores)

VMem Limit Quota

If applicable, The amount of virtual memory limit the pod has allocated against the namespace quota. Measured in Megabytes (MB)

VCPU Limit Quota

If applicable, The amount of virtual CPU limit the pod has allocated against the namespace quota. Measured in millicores (mCores)

Container Spec**VMem**

The virtual memory historically utilized by any containers run for this workload against the memory limit (if no limit is set, then node capacity is used). Measured in Megabytes (MB)

VCPU

The virtual CPU historically utilized by any containers run for this workload against the CPU limit (if no limit is set, then node capacity is used). Measured in millicores (mCores)

VMem Request

If applicable, the virtual memory historically utilized by any containers run for this workload against the memory request. Measured in Megabytes (MB)

VCPU Request

If applicable, the virtual CPU historically utilized by any containers run for this workload against the CPU request. Measured in millicores (mCores)

Workload Controller

VMem Request Quota

If applicable, The amount of virtual memory request the pod has historically allocated for this workload against the namespace quota. Measured in Megabytes (MB)

VCPU Request Quota

If applicable, The amount of virtual CPU request the pod has historically allocated for this workload against the namespace quota. Measured in millicores (mCores)

VMem Limit Quota

If applicable, The amount of virtual memory limit the pod has historically allocated for this workload against the namespace quota. Measured in Megabytes (MB)

VCPU Limit Quota

If applicable, The amount of virtual CPU limit the pod has historically allocated for this workload against the namespace quota. Measured in millicores (mCores)

Namespace

VMem Request Quota

The total amount of virtual memory request for all pods allocated to the namespace against the namespace quota. Measured in Megabytes (MB)

VCPU Request Quota

The total amount of virtual CPU request for all pods allocated to the namespace against the namespace quota. Measured in millicores (mCores)

VMem Limit Quota

The total amount of virtual memory limit for all pods allocated to the namespace against the namespace quota. Measured in Megabytes (MB)

VCPU Limit Quota

The total amount of virtual CPU limit for all pods allocated to the namespace against the namespace quota. Measured in millicores (mCores)

Virtual Machine (Node)

VMem

The virtual memory utilized by the node against the memory allocated to the hosting virtual machine. Measured in Megabytes (MB)

VCPU

The virtual CPU utilized by the node against the CPU allocated to the hosting virtual machine. Measured in Megahertz (Mhz)

VMem Request

The total amount of virtual memory allocated to pods with memory request against the allocatable capacity of the node. Measured in Megabytes (MB)

VCPU Request

The total amount of virtual CPU allocated to pods with CPU request against the allocatable capacity of the node. Measured in Megahertz (Mhz)

Number Consumers

The total number of pods running on the node against the maximum number of pods allowed. Measured in Pods (#)

Infrastructure-dependent Commodities

Depending on the technology the node is stitched to for underlying infrastructure, there may be additional commodities, or more granular data reported to existing commodities. See the Target Configuration Guide documentation for the appropriate technology to discover what data will be reported.

Fabric Targets

A fabric target is a service that unites compute, network and storage access into a cohesive system. When you connect Turbonomic to fabric targets, it monitors the performance and resource consumption of your

fabric interconnects, IO modules, chassis, and physical machines to assure application performance and utilize resources as efficiently as possible.

Once connected, Turbonomic discovers the blade servers that host the VMs, the chassis and datastores that provide resources to the blade servers, the IO modules and fabric interconnects that provide network resources, and the virtual datastores that provide storage resources to the VMs.

As part of this process, Turbonomic will stitch information from the fabric target and connected hypervisor targets to provide more granular data and information related to the applications and VMs running on the hypervisor-stitched blade servers. Combined with other targets, this information will support a top-down, application-driven approach to managing your environment.

For example:

When Turbonomic discovers that blade servers housed in a particular chassis have been designated as vCenter hosts, the supply chain stitches the blade servers and chassis to the corresponding vCenter datacenter to establish their relationship. When you set the scope to that datacenter and view the Health chart, you will see the blade servers in the list of hosts. In addition, when the datacenter is included in a merge policy (a policy that merges datacenters for the purpose of VM placement), the VMs in the blade servers apply the policy, allowing them to move between datacenters as necessary.

When you add application server targets, your applications and their individual components and services are discovered, enabling a view of your infrastructure from an individual application service to the physical hardware. Adding public cloud targets also allow for workloads to potentially migrate from your UCS infrastructure to the cloud, based on cost or available resources.

Supply Chain

Fabric targets add IO Module, Fabric Interconnect, Domain, and Chassis entities to the supply chain. The Chassis entities host physical machines (blade servers) — The physical machines also consume network connection commodities from IO Modules. The Fabric Interconnect supplies connectivity to the overall network, and also hosts the UCS Manager for UCS Targets. The Domain serves as the bottom-level pool of network resource, supplying the Fabric Interconnect.

Monitored Resources

Turbonomic monitors the following resources for the fabric supply chain:

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Blade

- Net
The utilization of data through the Blade's network adapters
Measured in Kilobytes per second (KB/s)

- Treated as a Physical Machine of the underlying Hypervisor (see below)
CPU, Mem, etc.

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
- CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Megahertz (MHz)

I/O Module

- NetThroughput
Rate of message delivery over a port
Measured in Megabits per second (Mb/s)

Switch

- NetThroughput
Rate of message delivery over a port
Measured in Mb/s
- PortChannel
Amalgamation of ports with a shared net throughput and utilization
Measured in Mb/s

Cisco UCS Manager

The Cisco Unified Computing System (UCS) Manager is a management solution that participates in server, fabric, and storage provisioning, device discovery, inventory, configuration, diagnostics, monitoring, fault detection, auditing, and statistics collection.

Turbonomic supports UCS Manager 2.2+.

UCS integrates all of these resources in a scalable multi-chassis platform to converge administration onto a single point. Managing these various entities on a network fabric with Turbonomic enables automation at the hardware level, including automated provisioning of hosts.

Prerequisites

- A service account Turbonomic can use to connect to UCS Manager

Entity Mapping

Turbonomic Mapping	UCS
Host	Server / Blade / Rack Unit
Chassis	Chassis
Datacenter	Datacenter
IO Module	IO Module
Switch	Fabric Interconnect
Network	Network

Adding UCS Targets

To add a UCS target, select the **Fabric and Network** category and choose one of the UCS Fabric options to match the version of UCS you want to manage. Then provide the following information:

- **Address:** The IP address of the UCS Manager

This gives access to the Fabric Manager that resides on the interconnect.

Turbonomic connects to the UCS Manager via the HTTP protocol by default.

- **Username/Password:** The credentials of the account Turbonomic will use to connect to UCS Manager.

specify the IP address and credentials for UCS Manager. Turbonomic discovers the fabric interfaces associated with that manager.

Note:

When providing a username, if the account is managed in Active Directory you must include the domain in case-sensitive spelling. For example, `MyDomain\john` is not the same as `mydomain\john`. For local user accounts, just provide the username.

- **Port Number:** The port Turbonomic will use to connect to the target.
- **Secure Connection:** When checked, Turbonomic will connect using SSL.

Supply Chain

Fabric targets add IO Module, Fabric Interconnect (Switch), and Chassis entities to the supply chain. The Chassis entities host hosts — The hosts also consume network connection commodities from IO Modules. The Fabric Interconnect supplies connectivity to the overall network, and also hosts the UCS Manager. The Domain serves as the bottom-level pool of network resource, supplying the Fabric Interconnect.

Actions

Turbonomic recommends actions for the various entities of the UCS Fabric Network as follows:

Physical Machines

- Start Physical Machine
- Provision Physical Machine
- Suspend Physical Machine

Chassis

- Provision New Chassis

Fabric Interconnect

- Add Port to Port Channel
- Remove Port from Port Channel
- Add Port

DPod (if Network Flow target is present)

- Provision new DPod

Monitored Resources

Turbonomic monitors the following commodities of the UCS target:

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
- CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Megahertz (MHz)

Chassis

- Power

Electricity being consumed by the Chassis

Measured in Watts (W)

- Cooling

The percentage of the acceptable temperature range that is utilized by this chassis. As the chassis temperature nears the high or low running temperature limits, this percentage increases.

I/O Module

- NetThroughput

Rate of message delivery over a port

Measured in Megabits per second (Mb/s)

Switch

- NetThroughput

Rate of message delivery over a port

Measured in Mb/s

- PortChannel

Amalgamation of ports with a shared net throughput and utilization

Measured in Mb/s

DPod (if Network Flow target is present)

- Memory (Mem)

The utilization of the DPod's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the DPod's CPU reserved or in use

Measured in Megahertz (MHz)

- Storage

The utilization of the storage attached to the DPod

Measured in Kilobytes (KB)

- Flow

The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization

Measured in Kilobytes per second (KB/s)

HPE OneView

HPE OneView is a management solution that streamlines provisioning and lifecycle management across compute, storage, and fabric. Through a unified API, infrastructure can be configured, monitored, updated, and re-purposed.

HPE OneView integrates all of these resources in a scalable multi-enclosure platform to converge administration onto a single point. Managing these various entities on a network fabric with Turbonomic enables automation at the hardware level, including automated provisioning of hosts.

Prerequisites

- A service account Turbonomic can use to connect to HPE OneView.
- HPE OneView 2.0 and compatible hardware.

- The **Banner Page** option for the user account should be disabled in the HPE OneView user interface.
- You should disable **Require Acknowledgement** for the user account in the HPE OneView user interface.

Adding HPE OneView Targets

To add a HPE OneView as a target, select the **Fabric** category and choose the HPE OneView radio button. Then provide the following information:

- **Address:**

The IP address of the HPE OneView target

This gives access to the Fabric Manager that resides on the VM.

Turbonomic uses the HTTPS protocol by default. In order to force the HTTP protocol, the Address must be entered in one of two ways. For example, an IP of 8.8.8.8 must be entered as http://8.8.8.8 or by using a specific HTTP port, such as 8.8.8.8:80.

- **Username/Password:**

The credentials of the account Turbonomic will use to connect to the HPE OneView target.

specify the IP address and credentials for HPE OneView. Turbonomic discovers the fabric interfaces associated with that instance.

Note:

When providing a username, if the account is managed in Active Directory you must include the domain in case-sensitive spelling. For example, MyDomain@john is not the same as mydomain@john. For local user accounts, just provide the username.

Supply Chain

Fabric targets add IO Module, Fabric Interconnect (Switch), Domain, and Chassis entities to the supply chain. The Chassis entities host physical machines — The physical machines also consume network connection commodities from IO Modules. The Fabric Interconnect supplies connectivity to the overall network. The Domain serves as the bottom-level pool of network resource, supplying the Fabric Interconnect.

Note:

For HPE OneView targets, the "Fabric Interconnect" entity exists as a false "Switch", and only as a pass-through for network resources. Unlike other fabric targets, such as UCS, there is no physical hardware that serves this function.

Actions

Turbonomic recommends actions for the various entities of the HPE OneView Fabric Network as follows:

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
- Suspend VM
- Provision VM

Physical Machines

- Start Physical Machine
- Provision Physical Machine

- Suspend Physical Machine

Fabric Interconnect

- Add Port to Port Channel
- Remove Port from Port Channel
- Add Port

DPod (if Network Flow target is present)

- Provision new DPod

Monitored Resources

Turbonomic monitors the following commodities of the HPE OneView target:

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared memory among VMs running on the host. ESX-only

Measured in Kilobytes (KB)

- CPU Ready

The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only

Measured in Megahertz (MHz)

Storage

- Storage Amount

The utilization of the datastore's capacity

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the datastore's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the datastore

Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency

The utilization of latency on the datastore

Measured in Milliseconds (ms)

I/O Module

- NetThroughput

Rate of message delivery over a port

Measured in Megabits per second (Mb/s)

Switch

- NetThroughput

Rate of message delivery over a port

Measured in Mb/s

- PortChannel

Amalgamation of ports with a shared net throughput and utilization

Measured in Mb/s

DPod (if Network Flow target is present)

- Memory (Mem)

The utilization of the DPod's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the DPod's CPU reserved or in use

Measured in Megahertz (MHz)

- Storage

The utilization of the storage attached to the DPod

Measured in Kilobytes (KB)

- Flow

The utilization of the network flow capacity utilized by the DPod. This is divided into Flow1 (Low Cost) and Flow2 (Medium Cost) utilization

Measured in Kilobytes per second (KB/s)

Guest OS Processes Targets

Using WMI (Windows Management Instrumentation) or SNMP, Turbonomic can discover OS processes that are running on your VMs. Analysis creates an Application Component entity for each process.

Turbonomic does not generate actions for these discovered Application Components. For many types of applications, you can configure a target dedicated to that application. You should use Guest OS Process targets for cases where there is no other target you can use for the application. For more information, see [Applications and Databases Targets](#).

WMI

Turbonomic will discover application and operating system resources using WMI (Windows Management Instrumentation) in your entire environment, or a portion of your environment, based on scope.

Prerequisites

- Underlying VM host targets added to Turbonomic (for discovery)
- A WMI user account Turbonomic can use to connect to the WMI targets. This account can either be an administrator user, or a non-administrator belonging to certain local user groups. For a full list of requirements, see [Creating a WMI User Account](#)
- WMI enabled on target VMs. For assistance in enabling WMI, see [Enabling WMI](#).

Note:

For Hyper-V hosts, you must install Hyper-V Integration Services on the target VMs. For more information, please refer to the following integration services TechNet article:

<https://technet.microsoft.com/en-us/library/dn798297%28v=ws.11%29.aspx>

For VMware hosts, you must install VMware Tools on the target VMs.

Adding WMI Targets

To add WMI targets, select the **Guest OS Processes > WMI** option on the Target Configuration page and provide the following information:

- Target Name

The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

- Username

The username Turbonomic will use to connect to the WinRM service on the Virtual Machine hosting the application. This should not include the Active Directory domain.

- Password

The password Turbonomic will use to connect to the WinRM service on the Virtual Machine hosting the application.

- Scope

Turbonomic will search for Windows applications on the VMs found within the set scope. This scope can be set to the entire environment, single or multiple clusters, or particular virtual machines. Select this option and choose the scope for application discovery.

Note:

A single scope (target) must not contain more than 500 virtual machines. Turbonomic recommends utilization of multiple WMI targets for environments exceeding this limit. Contact Turbonomic Support for assistance in using multiple WMI targets.

- Domain Name

The Active Directory domain used by Turbonomic in conjunction with the Username for authentication. Leave blank for local accounts.

- Full Validation

When selected, Turbonomic will require all database servers hosted on the VMs in the selected scope to be a valid target. If Turbonomic is unable to authenticate a database server in the scope, the target will not validate and data will not be collected.

Enabling Guest Load Metrics

Note:

For environments that use WMI or SNMP probes, you must configure the Turbonomic installation to enable guest load metrics. Without this configuration, the WMI and SNMP probes will not display discovered guest load data.

To enable guest load metrics, you must edit the CR file and restart the platform:

1. Open `/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml` for editing.
2. Enable guest metrics in the `properties` section of the file:

```
properties:
  repository:
    showGuestLoad: true
```

3. Save your changes to the file.
4. Apply your changes.

Execute the command:

```
kubectl apply -f /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

5. To restart the component, delete the repository pod.

Execute the command (where `{POD_ID}` is the ID that is appended to the pod in the `get pods` listing):

```
kubectl delete pod -n turbonomic repository-{POD_ID}
```

Supported Actions

Note:

The specific actions that Turbonomic recommends can differ, depending on the processes that Turbonomic discovers. For entities that you can add as individual targets, find the list of related actions in the sections for that target type in the *Target Configuration Guide*.

For other application components, Turbonomic can recommend actions based on the resources it can discover for the application. For example, Node.js® applications report CPU usage, so Turbonomic can generate vCPU resize actions and display them in the user interface.

For each discovered entity within the application supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

Applications

Without separate targets to discover Guest OS Processes or Application Servers, Turbonomic does not generate actions on applications. Instead, it generates resize actions on the host VMs. For on-prem environments, if host utilization is high enough on the physical machine running the application VM, Turbonomic can also recommend provisioning a new host.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
- Suspend VM
- Provision VM

Monitored Resources

Turbonomic monitors the following resources for the container supply chain:

WMI/SNMP Application

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Creating a WMI User Account

The service account Turbonomic uses to connect to WMI should be an Active Directory domain account.

Some enterprises require that the service account does not grant full administrator rights. In that case, you can create a restricted service account for WMI:

1. Add the account to each of the following local groups:

- WinRMRemoteWMIUsers__ (or Remote Management Users)
- Performance Monitor Users

Note:

These groups are standard Windows Server 2012 security groups. If you are using an earlier version of Windows Server and do not see these groups, contact IBM Support for assistance.

2. Grant permissions to the account.

In the WMI Management console, grant the **Enable Account** and **Remote Enable** advanced security permissions to the service account:

- Open the WMI Management console (wimgmt).
- Right-click **WMI Control (Local)** and choose **Properties**.
- Go to the **Security** tab and then click **Security** to display the **Security for Root** dialog.
- Click **Advanced**, select the service account, and click **Edit**.
- Confirm that **This namespace and subnamespace** is selected.
- Select **Enable Account** and **Remote Enable** and click **OK**.

Enabling WMI

Enabling Discovery

To enable Turbonomic discovery of Windows-based Guest Processes, you must configure and enable WMI with WinRM, usually by using a group policy for AD Domains.

When local credentials are provided to Turbonomic, NTLM is the authentication mechanism. When domain credentials are provided, either NTLM or Kerberos can be specified.

Note:

If Kerberos is specified, the IP address of the target must be resolvable to a host name using DNS.

While these steps will change slightly between Windows Server versions, the general instructions are:

1. Open an elevated PowerShell prompt on the virtual machine(s) to be discovered as a WMI Target.
2. Enable the WS-Management protocol and set the default configuration for remote management.

Execute `winrm quickconfig`.

3. Enable the WinRM *Negotiate* authentication scheme.

This policy is enabled by default. To enable this policy if it is disabled, execute `winrm set winrm/config/service/auth '@{Negotiate="true"}'`.

4. Set the WinRM `AllowUnencrypted` property to `true` if non-SSL connections are preferred.

This property must be set on both the server and the client. Note that setting this value to `true` does not mean that WMI passes sensitive data in an unencrypted form. It will send only the content of the SOAP messages as plain text:

- Server setting:

```
winrm set winrm/config/service '@{AllowUnencrypted="true"}'
```

- Client setting:

```
winrm set winrm/config/client '@{AllowUnencrypted="true"}'
```

5. Restart the Remote Registry service.

After restarting the Remote Registry service, Turbonomic will discover the WMI targets.

SSL Connections

To connect using SSL, then a certificate must be assigned to WinRM, and an SSL listening socket enabled. Turbonomic will accept self-signed certificates. Complete details can be found in the official WinRM documentation.

Some example SSL-related commands:

- List certificates on the system:

```
ls cert://localmachine/my
```

- Find Thumbprint for the default certificate:

```
7B56C33F029E7605D5C58E5597D0A077FE1D7F1C CN=winsql-server1.corp.mycorp.com
```

- Enable SSL listener:

```
winrm create winrm/config/listener?Address=*&Transport=HTTPS
@{Hostname="winsql-server1.corp.mycorp.com";CertificateThumbprint="7B56C33F029E7605D5C58E5597D0A077FE1D7F1C";Port="5986"}
```

SNMP

Turbonomic will discover application and operating system resources using SNMP (Simple Network Management Protocol) on Linux hosts within the specified scope of your environment.

Prerequisites

- Underlying VM host targets added to Turbonomic (for discovery)
- SNMP service enabled/configured on target VMs to allow access to the OIDs required. The credentials used must allow access to the following OIDs:
 - 1.3.6.1.2.1.1.1 - sysDescr
 - 1.3.6.1.2.1.25.4.2.1.2 - hrSWRunName
 - 1.3.6.1.2.1.25.5.1.1 - hrSWRunPerfEntry
 - 1.3.6.1.2.1.25.3.3.1.2 - hrProcessorLoad
 - 1.3.6.1.4.1.2021.4.5 - memTotalReal
 - 1.3.6.1.4.1.2021.4.6 - memAvailReal
 - 1.3.6.1.4.1.2021.4.11 - memTotalFree
 - 1.3.6.1.4.1.2021.4.14 - memBuffer
 - 1.3.6.1.4.1.2021.4.15 - memCached

Note:

For environments that include SNMP targets, Turbonomic can discover incorrect memory values for Linux systems. This can occur for the systems that use the net-snmp package, version 5.7.2-43.el7. You should use versions less than 5.7.2-43.el7, or greater than or equal to 5.7.2-47.el7.

For Hyper-V hosts, you must install Hyper-V Integration Services on the target VMs. For more information, please refer to the following integration services TechNet article:

<https://technet.microsoft.com/en-us/library/dn798297%28v=ws.11%29.aspx>

For VMware hosts, you must install VMware Tools on the target VMs.

Adding SNMP Targets

To add SNMP targets, select the **Guest OS Processes > SNMP** option on the Target Configuration page and provide the following information:

- Target Name

The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

- Scope

Turbonomic will search for SNMP applications on the VMs found within the set scope. This scope can be set to the entire environment, single or multiple clusters, or particular virtual machines. Select this option and choose the scope for application discovery.

Note:

A single scope (target) must not contain more than 500 virtual machines. Turbonomic recommends utilization of multiple WMI targets for environments exceeding this limit.

- Community

The SNMP v2c community string Turbonomic will use to connect to the SNMP agent on the VM

- Port number

The Port number Turbonomic will use to connect to the SNMP agent on the VM

- Full Validation

When selected, Turbonomic will require all database servers hosted on the VMs in the selected scope to be a valid target. If Turbonomic is unable to authenticate a database server in the scope, the target will not validate and data will not be collected.

- Enable SNMPv3

When checked, Turbonomic will use SNMPv3 to connect to the virtual machines in the selected scope

- SNMPv3 Username/SecurityName

The Username/SecurityName that Turbonomic will use to connect to the virtual machines hosting the application

- SNMPv3 Enable Privacy

When checked, Turbonomic will encrypt using the privacy password to keep the connection private.

- SNMPv3 Authentication Password

The Authentication Password Turbonomic will use to connect to the virtual machines in the selected scope. This allows requests to be authenticated, confirming the sender's identity.

- SNMPv3 Privacy Password

The Privacy Password Turbonomic will use to connect to the virtual machines in the selected scope. For requests to be encrypted, the SNMP manager and the SNMP agent must share knowledge of the privacy password associated with the username.

- SHA-1 For Authentication

When checked, Turbonomic uses SHA-1 Authentication to connect to the virtual machines in the selected scope. When unchecked, Turbonomic uses MD5

- AES For Privacy

When checked, Turbonomic will use AES 128 to connect to the virtual machines in the selected scope. When unchecked, Turbonomic uses DES

Note:

Turbonomic does not support AES 192 or 256 for SNMP targets.

Enabling Guest Load Metrics

Note:

For environments that use WMI or SNMP probes, you must configure the Turbonomic installation to enable guest load metrics. Without this configuration, the WMI and SNMP probes will not display discovered guest load data.

To enable guest load metrics, you must edit the CR file and restart the platform:

1. Open `/opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml` for editing.
2. Enable guest metrics in the `properties` section of the file:

```
properties:
  repository:
    showGuestLoad: true
```

3. Save your changes to the file.
4. Apply your changes.

Execute the command:

```
kubectl apply -f /opt/turbonomic/kubernetes/operator/deploy/crds/charts_v1alpha1_xl_cr.yaml
```

5. To restart the component, delete the repository pod.

Execute the command (where `{POD_ID}` is the ID that is appended to the pod in the `get pods` listing):

```
kubectl delete pod -n turbonomic repository-{POD_ID}
```

Supported Actions

Note:

The specific actions that Turbonomic recommends can differ, depending on the processes that Turbonomic discovers. For entities that you can add as individual targets, find the list of related actions in the sections for that target type in the *Target Configuration Guide*.

For other application components, Turbonomic can recommend actions based on the resources it can discover for the application. For example, Node.js® applications report CPU usage, so Turbonomic can generate vCPU resize actions and display them in the user interface.

For each discovered entity within the application supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

Applications

Without separate targets to discover Guest OS Processes or Application Servers, Turbonomic does not generate actions on applications. Instead, it generates resize actions on the host VMs. For on-prem environments, if host utilization is high enough on the physical machine running the application VM, Turbonomic can also recommend provisioning a new host.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
- Suspend VM
- Provision VM

Monitored Resources

Turbonomic monitors the following resources for the application supply chain:

WMI/SNMP Application

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Enabling SNMP

Turbonomic requires that SNMP is enabled and configured in order to discover Guest Processes. While these steps will change slightly between OS versions, this topic gives you the general instructions:

Enabling SNMP v2

1. Obtain and install the SNMP server package for your Linux distribution and version. This is commonly called `net-snmp` in most package managers. Also install the `net-snmp-utils` package if it is available
2. Configure the SNMP daemon by editing `/etc/snmp/snmpd.conf` or running `snmpconf -i` at the command line in order to verify that:
 - SNMP v2c is enabled
 - A read-only community name has been set. This community name will be used by Turbonomic to communicate with the SNMP agent on the VM

Note:

The community name you select must have at least read-only access to all OIDs in the system.

3. Configure the daemon to listen on a public interface. Most default installations only listen on `127.0.0.1`
4. Start the SNMP daemon process

These long form and short form sample `snmp.conf` files illustrate the necessary changes.

Long form, VACM:

```
# First, map the community name "mycommunity1" into a "security name"
# sec.name source community
# com2sec notConfigUser default mycommunity1
# Second, map the security name into a group name:
# groupName securityModel securityName
# group notConfigGroup v2c notConfigUser
# Finally, grant the group read-only access to any UUID.
# group context sec.model sec.level prefix read write notif
# access notConfigGroup "" any noauth
# exact all none none
```

Short form, older syntax:

```
rocommunity mycommunity1 default system
```

Verify Your SNMP Setup

Verify that your SNMP setup is successful by using the following command from a remote machine, replacing the community string and IP address:

```
snmpwalk -Os -v 2c -c COMMUNITY_STRING IP_ADDRESS iso.3.6.1.2.1.1.1
```

If successful, the command will return the kernel version of the machine (similar to the output of `uname -a`)

Enabling SNMP v3

1. Obtain and install the SNMP server package for your Linux distribution and version.

Most package managers call this package `net-snmp`. To verify your configuration in step 5 below, you should also install the `net-snmp-utils` package on the Turbonomic VM.

2. Stop the SNMP service.
3. Create the SNMPv3 user.

Execute the following command:

```
net-snmp-config --create-snmpv3-user [-ro] [-A authpass] [-X privpass] [-a MD5|SHA] [-x DES|AES] [username]
```

For example, the command:

```
i. net-snmp-create-v3-user -ro -A snmpv3authPass -a SHA -X snmpv3encPass -x AES snmpv3user
```

results in output similar to:

adding the following line to `/var/lib/net-snmp/snmpd.conf`:

```
createUser snmpv3user SHA "snmpv3authPass" AES snmpv3encPass
```

adding the following line to `/etc/snmp/snmpd.conf`:

```
rouser snmpv3user
```

4. Verify your SNMP setup.

To verify the configuration, you can execute the following command on the Turbonomic VM:

```
snmpwalk -Os -v 2c -c COMMUNITY_STRING IP_ADDRESS iso.3.6.1.2.1.1.1
```

Hyperconverged Targets

A hyperconverged target is a service that unites compute, network and storage access into a cohesive system. When you connect Turbonomic to hyperconverged targets, it will monitor the performance and resource consumption of your hyperconverged infrastructure to maintain application performance while utilizing resources as efficiently as possible.

As part of this process, Turbonomic will stitch information from the hyperconverged target to the associated hypervisor and fabric targets, supporting Application Resource Management (ARM) and providing deeper insight into the state of the hardware and information related to the entities in the supply chain. Combined with application server targets, this information will support a top-down, application-driven approach to managing your environment.

Monitored Resources

Turbonomic monitors the following resources for the hyperconverged supply chain, once stitched to your hypervisor and other associated targets:

Note: The entities visible in the supply chain depend on what supplemental targets have been added in addition to the hyperconverged target.

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Blade

- Net
The utilization of data through the Blade's network adapters
Measured in Kilobytes per second (KB/s)
- Treated as a Physical Machine of the underlying Hypervisor (see below)
CPU, Mem, etc.

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)

- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
- CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Megahertz (MHz)

I/O Module

- NetThroughput
Rate of message delivery over a port
Measured in Megabits per second (Mb/s)

Switch

- NetThroughput
Rate of message delivery over a port
Measured in Mb/s
- PortChannel
Amalgamation of ports with a shared net throughput and utilization
Measured in Mb/s

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Disk Array

- Storage Amount
The utilization of the Disk Array's capacity.

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the Disk Array's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the disk array

Measured in Operations per second

- Latency

The utilization of latency, computed from the latency of each device in the disk array.

Measured in milliseconds (ms)

Cisco HyperFlex

Cisco HyperFlex provides a hyperconverged platform that combines the networking and compute power of UCS with the storage capabilities of the HyperFlex HX Data Platform.

With the additional and refined storage information provided by HyperFlex, Turbonomic narrows the Desired State and recommends actions using the joint compute and storage information, gaining valuable insight into the interconnected nature of your environment.

For Turbonomic to make the most informed decisions, you must also add the compute nodes and any associated hypervisors. HyperFlex environments typically include:

- Converged (HX) Nodes

A combination of the cluster's storage devices into a single multi-tiered, object-based datastore.

- Compute Nodes

Cisco B or C series servers that make up the compute resources of the cluster, and are typically managed by a hypervisor.

- Controller VMs

Each HyperFlex node includes a Controller VM that intercepts and handles all the I/O from associated virtual machines. Turbonomic will not recommend actions for these VMs.

Prerequisites

- A service account on the controller VM that Turbonomic can use to connect to the HyperFlex environment

Adding HyperFlex Targets

To add a HyperFlex target, select the **Hyperconverged > HyperFlex** option on the Target Configuration page and provide the following information:

- Address

The name or IP address of the HyperFlex controller VM. If a port is appended to the IP address, it must be a secure (HTTPS) port.

- Username/Password

Credentials for a user account Turbonomic will use to connect to the controller VM.

To specify a root user for the target, give the name as `local/root`. Note that earlier versions of Turbonomic accepted a username of `root`. If an existing HyperFlex target fails to validate after you have upgraded Turbonomic, then check to make sure the username for a root account is properly set to `local/root`.

If you use vSphere SSO for authentication to the HyperFlex target, you must prepend your username with vc-. For example, if your username is Administrator@vsphere.local, you would enter it as vc-Administrator@vsphere.local.

- Port Number

Port Number Turbonomic will use to connect to the controller VM.

Supply Chain

HyperFlex targets add Disk Array entities to the supply chain, and receive more granular information from the compute resources in your environment.

Entity Comparison

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in HyperFlex to those used in Turbonomic:

HyperFlex Name	Turbonomic Entity
Volume	Storage
HX Cluster	Disk Array

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

For each discovered entity, Turbonomic can recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
Storage		Move, Provision, Resize Up
Disk Array		Provision, Suspend, Resize Up

Note:

For this target, Turbonomic discovers the HX Cluster as a Disk Array. When you see a provision action on this entity, you should determine which of the following is most relevant, based on your environment:

- Add disks to converged nodes
- Add a new converged node
- Add a new HX Cluster

Monitored Resources

Turbonomic monitors the following storage resources:

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the datastore

Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency

The utilization of latency on the datastore

Measured in Milliseconds (ms)

Disk Array

- Storage Amount

The utilization of the Disk Array's capacity.

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the Disk Array's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the disk array

Measured in Operations per second

- Latency

The utilization of latency, computed from the latency of each device in the disk array.

Measured in milliseconds (ms)

Nutanix

Nutanix products provide hyperconverged platforms that include VM hosting and a distributed storage fabric. The platform presents storage in two tiers — Local HDD storage and server-attached flash (hot storage).

Nutanix environments may include:

- One or more Nutanix appliances

An appliance contains up to four server nodes.

- Nutanix nodes

Servers that expose compute and storage resources. Each node provides local HDD and hot storage. Nodes combine to form a unified cluster that pools resources.

- Controller VMs

Each node includes a Controller VM that manages the node's resources within the cluster pool. To minimize storage latency, the Controller VM keeps the most frequently accessed data in the hot storage.

Turbonomic supports management of Nutanix fabrics, where the supply chain treats a Nutanix Storage Pool as a disk array. Turbonomic recognizes Nutanix storage tiers when calculating placement of VMs and VStorage. In addition, Turbonomic can recommend actions to scale flash capacity up or down by adding more hosts to the cluster, or more flash drives to the hosts.

To specify a Nutanix target, provide the Cluster External IP address. This is a logical IP address that always connects to one of the active Controller VMs in the cluster. In this way, you can specify a Nutanix target without having to specify an explicit Controller VM.

Note:

The Controller VM must remain *pinned* to its host machine — You must not move the Controller VM to a different host. If the Nutanix cluster uses the Nutanix Acropolis OS to manage VMs, Turbonomic automatically pins the Controller VMs. However, if you use vCenter Server or Hyper-V to manage VMs on the hosts, you must configure a group to pin the Controller VMs. For more information, see [Pinning Nutanix Controller VMs in Generic Hypervisor Mode](#).

Prerequisites

- A service account with cluster administrator rights on the Nutanix cluster(s) for action execution. For entity discovery, a minimum of READ access is required.

Finding the Cluster External IP Address

To configure a Nutanix target, provide the Cluster External IP address for the given Nutanix cluster.

The Cluster External IP address is a logical IP that resolves to the cluster's Prism Element Leader. If the Prism Element Leader fails, then the Cluster External IP address will resolve to the newly elected Prism Element Leader.

To find this IP address, open the Web Console (the Prism Element) on the cluster and navigate to the **Cluster Details** view. In this view you can see the **Cluster External IP** address. If there is no IP address specified, you can specify the address at this time. For more information, see the Nutanix documentation.

Operating Modes

A Nutanix node is a server that hosts VMs — In this sense the node functions as a hypervisor. A cluster of nodes can host VMs using the following Hypervisor technologies:

- Nutanix Acropolis

The native Nutanix host platform, which combines software-defined storage with built-in virtualization.

- VMware ESXi
- Microsoft Hyper-V

Turbonomic supports Nutanix cluster management in the Generic Hypervisor Mode (ESXi or Hyper-V). In this mode you:

- Add each Hyper-V host or vCenter as a hypervisor target — This enables VM workload control for the respective hypervisor technologies
- Specify the Nutanix Cluster External IP address as the target address — This adds the cluster as a Storage Controller target to enable Turbonomic storage control

Controller VM Pinning

Each Nutanix node hosts a Controller VM that runs the Nutanix software and manages I/O for the hypervisor and all VMs running on the host. Each Controller VM must remain on its host node —The Controller VM must be *pinned* to that host, and must not be moved to any other host.

For more information about how to pin the Controller VM, see [Pinning Nutanix Controller VMs in Generic Hypervisor Mode](#).

Adding Nutanix Targets**Note:**

This describes how to add a Nutanix cluster to Turbonomic as a target. Before you add the cluster as a target, you should know which operating mode you intend. If you want Standalone mode, then you will have to enable that operating mode after adding the cluster. If you want Generic Hypervisor mode, then

you will have to add the hypervisors as targets after you have added the Nutanix cluster as a target. For more information, see [Hypervisor Targets](#).

To add Nutanix targets, select the **Hyperconverged > Nutanix** option on the Target Configuration page and provide the following information:

- Address
The Cluster External IP address for the Nutanix cluster.
- Port Number
The listening port of the cluster.
- Secure Connection
When Turbonomic will use a secure connection.
- Username/Password
Credentials for an account on the Nutanix cluster with sufficient privileges.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in Nutanix to those used in Turbonomic:

Nutanix Name	Turbonomic Entity
Container	Storage
Storage Pool	Disk Array
Nutanix Cluster	Storage Controller

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
VM (a Nutanix VM)	Move (Host), Resize Resize actions require the VM to power down, and power back on again. Note: Turbonomic can automate VMotion to hosts, but for storage moves on Nutanix Turbonomic only supports the Recommend action mode.	
Datastore ("Storage")	Provision, Resize Up, Resize Down, Suspend	Move
Disk Array		
Storage Controller		Provision

Monitored Resources

Turbonomic monitors the following storage resources:

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Disk Array

- Storage Amount
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the Disk Array's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the disk array
Measured in Operations per second
- Latency
The utilization of latency, computed from the latency of each device in the disk array.
Measured in milliseconds (ms)

Storage Controller

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- CPU
The utilization of the Storage Controller's allocated CPU
Measured in Megahertz (MHz)
- Storage Amount
The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.
Measured in Megabytes (MB)

Pinning Nutanix Controller VMs in Generic Hypervisor Mode

Each Nutanix node hosts a Controller VM that runs the Nutanix software and manages I/O for the hypervisor and all VMs running on the host. Each Controller VM must remain on its host node —The Controller VM must be *pinned* to that host, and must not be moved to any other host.

For a cluster in Generic Hypervisor mode (using vCenter or Hyper-V hypervisors), you must use Turbonomic policies to pin the Controller VMs to their respective nodes. To do this, you will create a dynamic group of Nutanix Controller VMs, and then disable move actions for all members of this group.

To pin the Controller VMs:

1. Create a group of Controller VMs.

In Turbonomic you can create dynamic groups based on VM name — All VMs with matching names automatically belong to the group. Nutanix uses the following naming convention for Control VMs:

NTNX-`<SerialNumber>`-A-CVM, where `<SerialNumber>` is the serial number of the Controller VM.

You can create a dynamic group that automatically includes these Nutanix controller VMs. (For complete instructions on creating groups, see [Creating Groups](#).)

- Create a new group

In Turbonomic navigate to **Settings > Groups** and create a new group.

- Set the group type to **Dynamic**
- Add a filter to match VMs by their names

Add a filter that uses the regular expression, `NTNX.*CVM`. This regular expression will match the Nutanix Controller VMs.

Be sure to save the group. All the Nutanix Controller VMs will automatically become members of this group.

2. Disable moves for all VMs in this group.

To do this, create an automation policy for the group and disable actions. (For complete instructions to create these policies, see [Creating Scoped Automation Policies](#).)

- In Turbonomic go to the Policy > Action > VM view
- Set the scope to the group you made

In the **Scope** column, expand **My Groups** and select the group you just made.

- Disable moves for this group

In the **Parameter** column under **Action Mode Settings**, set the value to **Disabled**. This will override the global action mode.

- Save the action mode settings

Be sure to click **Apply Settings Change**.

Hypervisor Targets

A hypervisor is a service that creates and runs virtual machines (VMs) and/or containers, providing these entities compute and storage resources. When you connect Turbonomic to hypervisor targets in your environment, Turbonomic assures application performance by utilizing these resources as efficiently as possible.

Once connected to a hypervisor target, Turbonomic discovers the VMs, containers, physical machines that host the VMs or containers, datastores that provide storage resources to the physical machines, and virtual datastores that provide storage resources.

As additional targets are added, Turbonomic will discover the resources belonging to your physical and virtual infrastructure. For example, adding the underlying hardware as part of a UCS and/or storage target

will provide additional visibility into the physical infrastructure of your environment. To extend the virtual infrastructure, application server or guest operating process targets can be added.

Turbonomic represents your environment holistically as a supply chain of resource buyers and sellers, all working together to meet application demand. By empowering buyers (VMs, instances, containers, and services) with a budget to seek the resources that applications need to perform, and sellers to price their available resources (CPU, memory, storage, network) based on utilization in real-time, Turbonomic maintains your environment within the desired state.

For more information, see [Application Resource Management](#)

Supply Chain

Each hypervisor requires a physical machine (host) and one or more datastores to provide compute and storage resources. Virtual machines (VMs) or containers run on those physical resources, and the VMs in turn provide resources to applications.

At the bottom of the supply chain, physical machines consume resources from data centers.

If your environment includes SAN technologies such as disk arrays, then the storage consumes resources from that underlying technology. If you add these storage targets, then Turbonomic extends the supply chain analysis into the components that make up the disk array. For more information, see [Storage Manager Targets](#).

Actions

Turbonomic recommends actions for the hypervisor supply chain as follows.

Note:

This is a general list of actions for entities discovered for hypervisors. Detailed actions per target are described in each target section.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
- Suspend VM
- Provision VM

Physical Machines

- Start Physical Machine
- Provision Physical Machine
- Suspend Physical Machine

Storage

- Start Storage
- Provision Storage
- Suspend Storage
- Move (only with Storage Targets configured)
- Resize (only with Storage Targets configured)

Consumer Virtual Datacenters

- Resize Consumer vDC

- Provision Consumer vDC

Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
- CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Megahertz (MHz)

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Datacenter

Note: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared of memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
- CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Kilobytes (KB)

Provider Virtual Datacenter

- Memory (Mem)
The utilization of the Datacenter's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the Datacenter's CPU reserved or in use
Measured in Megahertz (MHz)
- Storage
The utilization of the storage attached to the Provider vDC.
Measured in Kilobytes (KB)

Consumer Virtual Datacenter

- Memory (Mem)
The utilization of the Datacenter's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the Datacenter's CPU reserved or in use
Measured in Megahertz (MHz)
- Storage
The utilization of the storage attached to the Consumer vDC.
Measured in Kilobytes (KB)

Microsoft Hyper-V

If you have a small number of Hyper-V hosts in your environment, you can add them individually as Turbonomic targets. Also, if you have deployed the Hyper-V hosts in a clustered domain (for example as a failover cluster), you can specify one Hyper-V host as a target and Turbonomic automatically add the other members of that cluster.

Note that for large Hyper-V environments, it's typical to manage the hosts via System Center Virtual Machine Manager (VMM). You can specify the VMM server as a target and Turbonomic will use it to discover and manage its child Hyper-V hosts. If you use VMM, you should not add individual Hyper-V hosts as targets. For information about adding VMM targets, see [Adding Virtual Machine Manager Targets](#).

Note:

Even if you manage Hyper-V using a VMM target, you must still configure remote management on each Hyper-V server. This Hyper-V topic includes instructions to configure remote management – see [Enabling Windows Remote Management](#).

For accurate SMB storage calculations, Turbonomic requires a VMM target.

Prerequisites

- Create a user account that Turbonomic can use to connect to your Hyper-V servers. See [Creating a Service User Account in Hyper-V](#)
- Configure remote management on each Hyper-V server. Refer to [Enabling Windows Remote Management](#)
- The time on each Hyper-V host must be in synch with the rest of the managed Hyper-V environment.
- Your Hyper-V environment must not use Server Message Block (SMB) storage.

To manage SMB storage, Turbonomic requires a VMM target, and that VMM instance must manage the Hyper-V hypervisors and the SMB storage that they use.

Managing a Hyper-V plus SMB environment via Hyper-V targets will result in incorrect data collection for SMB storage.

Adding Hyper-V Targets

Once you've enabled remote management, you can add your Hyper-V hosts as targets. To add Hyper-V targets, select the **Hypervisors > Hyper-V** option on the Target Configuration page and provide the following information:

- Address

The FQDN of the Hyper-V host. If you're using the "Discover Host Cluster" below to add an entire cluster, enter the name of any one of the Hyper-V hosts in the cluster.

Note that you can enter an IP address for the host, but you must first configure an SPN on the host. IBM recommends that you use the FQDN in this field.

- Port number

The port number for the remote management connection. The default HTTP port is 5985; the default HTTPS port is 5986.

- Secure connection

Select this option to use a secure connection (HTTPS). Make sure the required certificate is configured for use on the host.

- Full domain name

The full domain name of the cluster to which the host belongs.

- Discover Host Cluster

Turbonomic discovers and adds all Hyper-V hosts in the named cluster if this option is checked. Note that each server must be configured to allow remote management. You may find it helpful to configure WinRM using a GPO so new servers are configured automatically (see [Enabling WinRM Via a GPO](#)).

- Username

The username of a user account Turbonomic can use to connect to the Hyper-V host. If you checked "Discover Host Cluster" in the field above, use an account that is valid for all Hyper-V hosts in that cluster.

- Password

Password for account used.

Note:

If your Hyper-V hosts are running in a Nutanix environment, you must understand pinning a Nutanix Controller VM. For more information, see [Pinning Controller VMs in Generic Hypervisor Mode](#).

Exporting Hyper-V Virtual Machines

In Hyper-V environments, you must be sure that all VMs have unique IDs.

Hyper-V supports the export of a VM, so that you can create exact copies of it by importing those exported files. The Copy import type creates a new unique ID for the imported VM. When importing VMs in your environment, you should always use the Copy import type.

Turbonomic uses the unique ID to discover and track a VM. If your environment includes multiple VMs with the same ID, then discovery will assume they are the same VM. As a result, the counts for VMs will be incorrect.

Supported Actions

For each discovered entity within the hypervisor supply chain, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations Only
Virtual Machine	Start, Move, Suspend, Resize Down, Resize Up	Terminate, Provision, Reconfigure
Physical Machine	Start, Suspend	Terminate, Provision
Storage		Provision

Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space

Measured in Kilobytes (KB)

Storage

- Storage Amount

The utilization of the datastore's capacity

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the datastore's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the datastore

Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency

The utilization of latency on the datastore

Measured in Milliseconds (ms)

Datacenter

Note: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- Memory (Mem)

The utilization of the PM's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the PM's CPU reserved or in use

Measured in Megahertz (MHz)

- IO

The utilization of the PM's IO adapters

Measured in Kilobytes per second (KB/s)

- Net

The utilization of data through the PM's network adapters

Measured in Kilobytes per second (KB/s)

- Swap

The utilization of the PM's swap space

Measured in Kilobytes (KB)

Creating A Service User Account

The service account Turbonomic uses to connect to a Hyper-V host must be an Active Directory domain account. The account must have full access to the cluster. To create such an account, execute the following command at a PowerShell prompt:

```
Grant-ClusterAccess <domain>\<service_account> -Full
```


Additionally, the service account must have specific local access rights on each host. The easiest way to grant Turbonomic the access it requires is to add the domain account to the Local Administrators group on each Hyper-V server.

Some enterprises require that the service account does not grant full administrator rights. In that case, you can create a restricted service account on every Hyper-V host.

Note:

Turbonomic does not support Restricted User Accounts on Windows 2012 Hyper-V nodes.

To create a restricted service account on your Hyper-V hosts:

1. Add the service account to each of the following local groups:
 - WinRMRemoteWMIUsers__ (or Remote Management Users)
 - Hyper-V Administrators
 - Performance Monitor Users

Note:

These groups are examples only. If your version of Windows Server does not include these groups, contact Technical Support for assistance.

2. Grant permissions to the service account.

In the WMI Management console, grant the following permissions to the service account:

- Enable Account
- Remote Enable
- Act as Operating System (For Windows 2016)

3. Configure the WinRM security descriptor to allow access by the service account:

- At a PowerShell prompt, execute `winrm configSDDL default`.
- In the "Permissions for Default" dialog box, grant the service account Read and Execute access.

vCenter Server

VMware vCenter Server provides a centralized management platform for VMware hypervisors. To manage your VMware environment with Turbonomic, you specify a vCenter Server instance as a target. Turbonomic discovers the infrastructure that target manages, and links it into a supply chain to deliver application performance management.

Prerequisites

- Target User Account

A user account that Turbonomic uses to connect to your vCenter and execute actions. For information about setting permissions for this account, see [Creating a User Account In vCenter](#).

General Considerations

Before you configure a vCenter Server target, you should consider the following:

- **Linked vCenters:**

For linked vCenters, you must add each vCenter separately so Turbonomic can communicate with each vCenter through a separate API endpoint.

- **Restricting Turbonomic Access to Specific Clusters:**

When you add a vCenter target, Turbonomic discovers all of the connected entities that are visible, based on the target account that it uses to connect to the vCenter target. If you have clusters or other entities you want to exclude from discovery, you can use the vSphere management client to the role of the Turbonomic account to No access for the given entities.

- **Shared Datastores:**

If you add more than one vCenter target that manages the same datastore, you can enable or disable datastore browsing to discover wasted files on the shared datastore:

- Enable datastore browsing:

To properly enable browsing, you must turn on the **Enable Datastore Browsing** option in the target configuration for each vCenter target that manages the shared datastore.

- Disable datastore browsing:

If you don't want datastore browsing over shared datastores, you must turn *off* the **Enable Datastore Browsing** option in the target configuration for each vCenter target that manages the shared datastore.

If set **Enable Datastore Browsing** differently for separate targets that manage the same datastore, datastore browsing can give inconsistent results for active and wasted files.

- **VSAN Permissions:**

In order to enable VSAN support and discover groups based on storage profiles, you must ensure that the user role Turbonomic is assigned has the Profile-driven storage view permission enabled. This permission is *disabled* in the built-in readonly role.

- **Guest Metrics:**

For vCenter Server environments, if you turn on **Enable Guest Metrics** for your target configuration, the metrics that vCenter returns to Turbonomic can be inaccurate, depending on the version of vCenter Server and VMware Tools that you have running on your VMs.

This target option will instruct that Turbonomic request from the VC instance that it start collecting and reporting enhanced memory metrics from each virtual machine, using the VMTools installed on each VM. Without this option, Turbonomic only has access to the "Active" memory for each virtual machine, which is a less accurate representation of the memory that the VM is really using.

For accurate metrics use vCenter Server 6.5U3 or higher with VMware Tools version 10.3.2 or higher on guest VMs. If you run vCenter Server version 7.0 or greater, then it can automatically update your VMware Tools through the user interface. For other versions of vCenter Server, you must manually update your VMware Tools deployments.

For the permissions required for Guest Metrics, see [vCenter Permissions](#).

Adding vCenter Targets

To add vCenter targets, select the **Hypervisors > vCenter** option on the Target Configuration page and provide the following information:

- Address

The name or IP address of the vCenter server.

- Username/Password

Credentials for the user account Turbonomic can use to connect to the vCenter Server. Include the domain if required (<domain>\<username>).

- Enable Datastore Browsing

Enabling datastore browsing enables Turbonomic to discover wasted storage.

- Enable Guest Metrics

Collecting advanced guest memory metrics can increase the accuracy of the VMEM data that Turbonomic uses for analysis of virtual machines. To enable guest metrics, ensure the following:

- VMware Tools is installed and running on the target VMs
- The **Hypervisor VMEM for Resize** vCenter option is active for the VMs discovered by the target.
- The user account has the `Performance.Modify Intervals` performance privilege

For more information, see [Hypervisor VMEM for Resize](#) and [vCenter Performance Privileges](#).

Note:

If your VMware hypervisors are running in a Nutanix environment, you must understand pinning a Nutanix Controller VM. For more information, see [Pinning Controller VMs in Generic Hypervisor Mode](#).

vCenter Imported Settings

In addition to discovering entities managed by the hypervisor, Turbonomic also imports a wide range of vSphere settings, such as Host DRS rules, annotations, Resource Pools, and DRS HA settings (See [Other Information Imported From vCenter](#)).

Note: Turbonomic does not import Storage DRS rules at this time.

VMware vSphere 6.0 introduced the ability to move VMs between vCenters. If you enabled this feature in your VMware environment, you can configure Turbonomic to include cross vCenter vMotions in its recommendations.

To configure Turbonomic to support cross vCenter vMotion recommendations, you must create a Workload Placement Policy that merges the datacenters on the different vCenters, and then another policy to merge the given clusters. Also note that the merged clusters must use the same network names in the different datacenters. To create a Merge Policy:

1. In the Policy Management Tab, select **Placement Policy**.
2. For policy type, select **Merge**.
3. For MERGE, choose the merge type, and click **Select**.

To merge datacenters choose Datacenter, to merge Host clusters choose Cluster, and for storage choose StorageCluster.

4. Choose the specific datacenters or clusters to merge in this policy, then click **Select**.
5. Click **Save Policy**.

Note:

Since Turbonomic can only execute vMotions between clusters that use the same switch type (VSS or VDS), make sure any clusters you merge use the same switch type. Although Turbonomic will not initiate VSS → VDS vMotions, vSphere may do so. If this happens, Turbonomic displays a compliance violation notification.

Supported Actions

For each discovered entity within the hypervisor supply chain, Operations Manager can execute or recommend certain actions, as outlined below.

Note:

In order to execute cross-VC migrations as a non-admin user, you must have the following permissions enabled for the user account in both origination and destination vCenters:

- Virtual Machine: Edit Inventory, Create From Existing (Move, Register, Remove, Unregister sub-options), Create New
- Datacenter: Reconfigure Datacenter
- Network: Assign Network

Entity Type	Can Be Automated	Recommendations Only
Virtual Machine	Start, Move, Suspend, Storage Move, Resize Down, Resize Up	Terminate, Provision, Reconfigure
Physical Machine	Start, Suspend	Terminate, Provision

Entity Type	Can Be Automated	Recommendations Only
Storage		Provision

Monitored Resources

Turbonomic monitors the following resources for the hypervisor supply chain:

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
- CPU Ready
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only

Measured in Megahertz (MHz)

Storage

- Storage Amount

The utilization of the datastore's capacity

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the datastore's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the datastore

Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency

The utilization of latency on the datastore

Measured in Milliseconds (ms)

Datacenter

Note: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- Memory (Mem)

The utilization of the PM's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the PM's CPU reserved or in use

Measured in Megahertz (MHz)

- IO

The utilization of the PM's IO adapters

Measured in Kilobytes per second (KB/s)

- Net

The utilization of data through the PM's network adapters

Measured in Kilobytes per second (KB/s)

- Swap

The utilization of the PM's swap space

Measured in Kilobytes (KB)

- Balloon

The utilization of shared of memory among VMs running on the host. ESX-only

Measured in Kilobytes (KB)

- CPU Ready

The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only

Measured in Kilobytes (KB)

Provider Virtual Datacenter

- Memory (Mem)

The utilization of the Datacenter's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the Datacenter's CPU reserved or in use

Measured in Megahertz (MHz)

- Storage

The utilization of the storage attached to the Provider vDC.

Measured in Kilobytes (KB)

Consumer Virtual Datacenter

- Memory (Mem)

The utilization of the Datacenter's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the Datacenter's CPU reserved or in use

Measured in Megahertz (MHz)

- Storage

The utilization of the storage attached to the Consumer vDC.

Measured in Kilobytes (KB)

Creating A Service User Account In vCenter

The service account you use must have specific permissions on the vCenter. The easiest way to grant Turbonomic the access it requires is to grant full administrator rights.

Some enterprises require that the service account does not grant full administrator rights. In that case, you can create a restricted service account that grants the following permissions to enable the required Turbonomic activities:

vCenter Permissions

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none">• Read-only role for all entity types <p>Assign either Global permissions or permissions for the given vCenter Server instance to the target user or user group.</p> <ul style="list-style-type: none">• Requirement to monitor VSAN and storage profiles <p>In order to enable VSAN support and discover groups based on storage profiles, you must enable the Profile-driven storage view permission. This permission is <i>disabled</i> in the built-in readonly role.</p>
Recommend Actions	<ul style="list-style-type: none">• Read-only role for all entity types

Turbonomic Functionality	Required Permissions
	Assign either Global permissions or permissions for the given vCenter Server instance to the target user or user group.
Wasted Storage Reporting	<ul style="list-style-type: none"> Datastore > Browse Datastore
Execute VM Move	<ul style="list-style-type: none"> Resources > Assign VM to Resource Pool Resources > Migrate Powered Off VMs Resources > Migrate Powered On VMs Resources > Modify Resource Pool Resources > Query Vmotion
Execute VM Storage Move	<ul style="list-style-type: none"> Datastore > Allocate Space Datastore > Browse Datastore Resources > Assign VM to Resource Pool Resources > Migrate Resources > Modify Resource Pool Resources > Move Resource Pool Resources > Query VMotion Virtual Machine > Change Configuration > Change resource Virtual Machine > Change Configuration > Change Swapfile placement
Execute VM Resize	<ul style="list-style-type: none"> Virtual Machine > Change Configuration > Change CPU count Virtual Machine > Change Configuration > Change Memory Virtual Machine > Change Configuration > Change resource Virtual Machine > Interaction > Reset Virtual Machine > Interaction > Power Off Virtual Machine > Interaction > Power On
Discover Tags	<ul style="list-style-type: none"> Global > Global tag <p>You must also open ports 10443 and 7443 on the target server</p>
Guest Metrics	<ul style="list-style-type: none"> Performance > Modify Intervals

Other Information Imported from vCenter

In addition to discovering entities managed by the vSphere hypervisors and their resources, Turbonomic:

- Imports any vSphere Host DRS rules when DRS is enabled, and displays them on the **Policy > Workload Placement** view under **Imported Placement Policies**. Imported rules are enabled by default, but you can disable them in Turbonomic.

Note:

In vCenter environments, Turbonomic does not import DRS rules if DRS is disabled on the hypervisor. Further, if Turbonomic did import an enabled DRS rule and somebody subsequently disables that DRS

rule, then Turbonomic will discover that the rule was disabled and will remove the imported placement policy.

- Imports any custom annotations and displays related groupings in the **Inventory > Groups** tree view, under **VC Annotations**. The service account must enable the **Global > Global tag** privilege, and the target server must open ports 10443 and 7443.
- For vCenter Server versions 5.5 and later, discovers Virtual Machine Storage Profiles and displays them as groups anywhere that you can set scope. The groups appear under **VC Storage Profiles**. You can use these discovered storage profiles the same as any other groups — For example, to scope dashboards, or to set the scope for specific action policies.
- Discovers resource pools and displays them as folders in the Inventory tree and as components in the Supply Chain Navigator. If you have the Cloud Control Module license, Turbonomic manages resource pools as Virtual Datacenters (VDCs) and can recommend resize actions. Root resource pools appear as Provider VDCs in the supply chain, whereas child resource pools appear as Consumer VDCs.
- Imports vSphere HA cluster settings and translates them into CPU and memory utilization constraints. These are displayed as cluster-level overrides under **Folders** on the **Policy > Analysis > Host** view.

Orchestrator Targets

Turbonomic supports Action Script and ServiceNow orchestrator targets.

With orchestrator targets you can integrate Turbonomic actions with the orchestrator's application management process. For example, you can pass Turbonomic to a Change Request system for approval, and the system can pass the action back to Turbonomic for execution.

Note:

Turbonomic uses remote servers to execute ActionScript orchestration. Managing the processes remotely means that you do not install custom code on the Turbonomic server. This eliminates associated security risks at that point. However, you are responsible to maintain the security of your action script server, and to ensure the integrity of your custom code.

ActionScript Server

Resource Requirements for the Server

The remote server can be a VM or a container. The capacity you configure for the server depends entirely on the processes you intend to run on it. Turbonomic does not impose any special resource requirements on the server.

Configuring Command Execution

To support execution of your scripts, you must install any software that is necessary to run the scripts. This includes libraries, language processors, or other processes that your scripts will invoke.

Turbonomic invokes the scripts as commands on the server. The server must run an SSH service that you have configured to support command execution and SFTP operations. At this time, IBM has tested action scripts with the OpenSSH sshd daemon.

The standard port for SSH is 22. You can configure a different port, and provide that for admins who configure the server as an ActionScript target.

Note that an action script can invoke any process you have deployed on the remote server. You do not have to run scripts per se. However, you must be able to invoke the processes from the command line. The script manifest gives Turbonomic the details it needs to build the command line invocation of each script.

Configuring the ActionScript User Account

To execute the scripts on your server, Turbonomic logs on via a user account that is authorized to execute the scripts from the command line. You provide the user credentials when you configure the ActionScript target. To support this interaction, the user account must meet the following requirements:

- Public Key

The user must have a public key in the `.ssh/authorized_keys` file. When you configure the ActionScript target, you provide this as the Private Token for the target.

Note:

For the ActionScript target to validate, the permissions on the `authorized_keys` file must be set to 600.

- Security for the `.ssh` Directory

The ActionScript User should be the only user with authorized access. You should set file permissions to 700.

- Supported Shells

The ActionScript User shell can be either the Bourne shell (usually at `/bin/sh`) or the Bourne-Again shell (usually at `/bin/bash`). Turbonomic passes parameters as it invokes your scripts. At this time it only supports script execution through these shells.

Handling ActionScript Timeouts

Turbonomic limits script execution to 30 minutes. If a script exceeds this limit, Turbonomic sends a SIGTERM to terminate the execution of the process.

Note that Turbonomic does not make any other attempt to terminate a process. For example you could implement the script so it traps the SIGTERM and continues to run. The process should terminate at the soonest safe opportunity. However, if the process does not terminate, then you must implement some way to terminate it outside of Turbonomic. Note that a runaway process continues to use its execution thread. This can block other processes (action scripts or primary processes) if there are no more threads in the pool.

Obtaining Private Key String

In order to pass the private key as a string, newlines must be inserted appropriately with the `\n` character, as the JSON format will not preserve these required newlines. One method to insert these lines on *nix systems is the `awk` command. This command should follow the following format: `awk 'ORS="\n"' path/to/keyfile > path/to/modified/keyfile`. For example, `awk 'ORS="\n"' ~/.ssh/id_rsa > /tmp/privkey.txt`. You can then `cat` or `vi/vim` the file to copy the text and insert it into the API call.

Example private key file, before modification:

```
-----BEGIN RSA PRIVATE KEY-----
MIIJKQIBAAKCAgEAxeKUK6WLFMf8seI2KztL4DoKKW0d6AG/39SH6or5SiNbAGkM
Umv8ABA0aCQqMF01j9V3kzGn71DIWWTxLOMBH06I01dvd9XYPVJRJotGjpxus+xmV
GbeXxJsdHfXibtMeLnpkwGC7gIu6W2o5Ez6YuLDKf+CeFZhGMOtVLiB2Nwtzn33D
KBh96tIom9EqKseovtQAj5VYDwPeuTaWX1RGMt11tsNGyezEc4Z2sppT4VFVhsUV
L+voDZzrtMfFiHUIgjPH4pK9c/iPj0um7YzmyMyARftyCsUg7iUZH4N1NLpikXVy
xKiro6Quu7SZ4kcvr3ZF3970C0N0hHzC3mFsvZvRFgYKzgc8/BcZ8ZzEUFfqBqY4
dejCU+jo86dYFL2Q8RfF2zsJenG0WbVRLtLGkc7RbMdBGjtt5roV5VAp+TyR9Hdd
Dc5FYvt4fAAMJtcmTIzdEAPsbVzDhkSajxRh0XvezJn+2Ddr34/9ZvFE7nJNgP/8
KOGJ5H1dgG5mc7H+Ly3x5dXzPhcVNSUdNGgKnEvzFgMJAgByAg5AZc5H0miIwFKs
KSE/m8dSR0HrHmenGGmk1IMUnvCC1mKkbUEJ2V6R17x8zmM4DYNRSTwcSL
SZ7U/yDuwpHwzeozNeoekGKeC23+jgyzr9/mzgmPF08q5F+wVg/7n1DRSXsCAwEA
AQKCAgBPHMPbt25AM6gCEfcoF3/BOFMCXS8cpz5npRdlnIQHsNTb+CN1/Df2aoQZ
MoQva8RTKbuxfE0weLJwktuc33B+bK51F+q31SXrdvwtfPSZHYFqXeJnX0upXjh
loS2f07vE/2dr86mmlY7f98ro3X50KzsrQdmiMdHwajl1TLJDgJy5TPf8K91RG
3zu1eMcs66MBxGo9LoXntDwwBog9e8Rk+fMeHwt46EQikXLpfNPdmoNa8kyGzLqr
PsbpRCjPrRX3rkTRZyJPeCZXiGJn2uJZmCpCxbhTrGZmLVofC+WCCeFeg2M0cHh
R1XSuJvTr7KtyvvzZcQah6p8r6SCASQFeVbb13FJVkBd0J8Hzk5e4N5Qk3bv9V4W
```

```

F7CC8dRV66kcAkf68ytLGXkQASgo5RPBDYSp8E2JDLF4m+9w6aouP1g//QxG5+XA
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XPRnND1c2c3fMqysNnDiklatDgIx5Grk1ZXwnKGth+2ZNipCHmw/IQxy8fWvae8n
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wEtAB2y/dprZj/JS3JGuWSP24hD/UpnD+PlJ0VsvfqiK4EquWrC1a1J+ivQln0UW
-----END RSA PRIVATE KEY-----

```

The same private key, after running the above command:

```

-----BEGIN RSA PRIVATE KEY-----\n
MIIEKQIBAAKCAgEAXeKUK6WLFmf8seI2KztL4DoKKw0d6AG/39SH6or5SiNBAGkM\
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```

```

MWYUvyDPRRwLqQu0Dpb1YKgAyihmU/Sw7c2wPp+sbZW/Rq8Euae8+Br1oJB1YjAP\n
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E4VxEPsgNYH1k2eqtGRQwYR0ML/fihHbJII1QnMr6o7/tK1jx+3PCZeRaVR4/\n
-----END RSA PRIVATE KEY-----\n

```

Adding ActionScript Targets to Turbonomic

Note: At this time, ActionScript Targets must be added using the API. The ActionScript target appears in the UI as a selection, but should not be used. For more information about the Turbonomic API and how to use it to add targets, see the Turbonomic API Guide.

The TargetApiInputDTO for this target has the following parameters:

nameOrAddress

IP or FQDN of the script execution server.

port

Port used to connect to the script execution server.

userid

Username used to connect to the script execution server.

privateKeyString

Path to the SSH private token corresponding to the user used to connect to the script execution server.

manifestPath

Path to the ActionScript manifest file on the script execution server.

Use the POST `https://10.10.10.10/api/v3/targets` request to add this target. Send the constructed TargetApiInputDTO as the body of the request.

Example Input:

```

{
  "category": "Orchestrator",
  "inputFields": [
    {
      "name": "nameOrAddress",
      "value": "10.10.10.10"
    },
    {
      "name": "port",
      "value": "22"
    },
    {
      "name": "userid",
      "value": "shepp"
    },
    {
      "name": "privateKeyString",
      "value": "-----BEGIN RSA PRIVATE KEY-----\nMIIJKQIBAAKCAgEAxeKUK6WLFMf8seI2KztL4DoKKw0d6AG/39SH6or5SiNbAGkM\nUmV8ABA0aCQqMF01j9V3kzGn71DIWWTxLOMBH0E101dvd9XYPVRJotGjpxus+xmV\nnGbeXxJsdHfXr\nbtMeLnpkwGC7gIu6W2o5Ez6YuLDKf+CeFZhGMOtVLiB2Nwtzn33D\nnKBh96tIom9EqKseovtQAj5VYDwPewTaWX1RGMT11ts\nNGyezEc4Z2sppT4VfVhsUV\nnL+voDZzrtMfFiHUIgjPH4pK9c/\niPj0um7YzmyMyARftyCsUg7iUZH4N1NLpikXVy\nnxKiro6Quu7S24kcvr3ZF3970CON0hHzC3mFsvZvRFgYKzgc8/\nBcZ8ZzEUFfqbQY4\nndeJCU+jo86dYFL2Q8RfF2zsJenG0WbVRLtLGkc7RbMdBGjtt5roV5VAp+TyR9Hdd\nnDc5FYvt4fAAMJ\ntcmTIZdEAPsbVzDhkSajxRh0XvezJn+2Ddr34/9ZvFE7nJNgP/\n8\nnKQGJ5H1dgG5mc7H+Ly3x5dXzPhcVNSUdNGgKnEvzFgMJAgByAg5AZc5H0miIwFKs\n\nnKSE/\nm8dSRoHrHmenGGm5TtA41u1IMUnvCC1mKkbUEJ2V6R17x8zmM4DYNRSTwcSL\n\nnSZ7U/\nyDuwpHwzeozNeoekGKeC23+jgyzr9/mzgmPF08q5F+wVg/7n1DRSxSAwEA\n\nnAQKCAgBPHMPbt25AM6gCEfcoF3/\nBOFMCXS8cpz5npRdlnIQHsNTb+CN1/\nDf2aoQZ\n\nnMoQva8RTKbuxfE0weLJwktuc33B+bK51F+q31SXrdvwtfPSZhYYFqXejnX0upXjh\n\nnloS2f07vE/\n2dr86mmlY7f98ro3X50KzsrQdmiMdFHwaJl1TLDJdgJy5TpF8K91RG\n\nn3zuleMcs66MBxGo9LoXntDwwBog9e8Rk+fMeHwt4\n6EQiKXLPfNPdmoNa8kyGzLqr\n\nnPsbpRCjPrX83rkTRZyJPeCZXiGJn2uJZmCpCxbhTrGZmLVofc+WcCefeg2M0cHh\n\nnR1XS\nUjVtr7KtyvvzZcQah6p8r6SCASQFvbb13FJVkBd0J8Hzk5e4N5Qk3bv9V4W\n\nnF7CC8dRV66kcAkf68ytLGXkQASgo5RPBDY\nSp8E2JDLF4m+9w6aouPlg//\nQxG5+XA\n\nnwqGJseTipiHbiALcIGsCpc5QCqab2SNddaDtIIpnp2Zmo5E10jutGeUAE3k+cnJ1\n\nnJIFCkRL0vsPk0xODSxbV2\n"
    }
  ]
}

```

```

PMAUjMT65ue7uBkDqCtgHiSBXTk6DiWBjduDnoZlAmC\nI8M4o42mSPs2uoKcngJ2fboY5iSsXLQ8VT5Tix8fk7VzBFm0vch
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Rq8Euaee8+Br1oJB1YjAP\nnITzx+WUqpgIb88Yc9qBiY8g5pmAdT0uTuGii3eN2Dot1u6QDpiphQQ/
f3WbK0XLGs\nt6EMG0qJfH5Ky9d1jfmD70j/IgaBLNstAoIBAQCkqJNuH7Fsta/KQ5fJzFrD/
M1l\nQ6yfb9D92UEabB1Et22Zr7Ry5WAv4DRcYwVlHrBJQB0w4Gc5WZcEnE1HvhkX519w\nnhccp1P+tyRf+h6ppYqd1/
Yaw2vEMTR1gvvtV8+2aMYTNRQJuTjJiSk1vWvX42IhQ\nnxqKM9xqmKGEsw+6e7UheaXY8afkjf20/
euGgzTuEPoy+IA8vKrSAnLLWm4xDYjMV\nni9PFbuSyRV6tJqQZx58dS2ykL5YpTLM+ZFyZmhAqSJWULpsKAxxE2fnnniXOY
VF\nE4VxEPsgNYH1k2eqtGRQwYR0ML/fihHbJl1QnMr6o7/tkljx+3PCZeRaVR4/\n-----END RSA PRIVATE KEY-----
\n"
    },
    {
      "name": "manifestPath",
      "value": "/home/shepp/action-script/manifest.json"
    }
  ],
  "type": "ActionScript"
}

```

The API will return the TargetApiDTO for the ActionScript target upon success, or an error message upon failure.

Example Response:

```

{
  "uuid": "73356329749216",
  "displayName": "10.10.10.10-/home/shepp/action-script/manifest.json",
  "category": "Orchestrator",
  "inputFields": [
    {
      "displayName": "Name or Address",
      "name": "nameOrAddress",
      "value": "10.10.10.10",
      "isMandatory": true,
      "isSecret": false,
      "isTargetDisplayName": false,
      "valueType": "STRING",
      "description": "IP or FQDNS for the Script Execution Server",
      "verificationRegex": ".*"
    },
    {
      "displayName": "Port",
      "name": "port",
      "value": "22",
      "defaultValue": "22",
      "isMandatory": false,
      "isSecret": false,
      "isTargetDisplayName": false,
      "valueType": "STRING",
      "description": "Port to use for the Script Execution Server",
      "verificationRegex": ".*"
    },
    {
      "displayName": "User ID",
      "name": "userid",
      "value": "shepp",
      "isMandatory": true,
      "isSecret": false,
      "isTargetDisplayName": false,
      "valueType": "STRING",
      "description": "Userid to use to execute command on the Script Execution Server",
      "verificationRegex": ".*"
    }
  ]
}

```

```

    },
    {
      "displayName": "Private Token",
      "name": "privateKeyString",
      "isMandatory": true,
      "isSecret": true,
      "isTargetDisplayName": false,
      "valueType": "STRING",
      "description": "SSH Private Token corresponding to the Userid",
      "verificationRegex": ".*"
    },
    {
      "displayName": "Script Path",
      "name": "manifestPath",
      "value": "/home/shepp/action-script/manifest.json",
      "isMandatory": true,
      "isSecret": false,
      "isTargetDisplayName": false,
      "valueType": "STRING",
      "description": "File Path to the ActionScript manifest file on the Execution Server",
      "verificationRegex": ".*"
    },
    {
      "displayName": "Public Host Key",
      "name": "hostKey",
      "isMandatory": false,
      "isSecret": false,
      "isTargetDisplayName": false,
      "valueType": "STRING",
      "description": "Public key presented by the SSH server for host authentication; if not provided, the presented key will be accepted and integrated into the target definition for future operations",
      "verificationRegex": ".*"
    }
  ],
  "lastValidated": "2020-07-28T20:46:22Z",
  "status": "Validated",
  "type": "ActionScript",
  "readonly": false
}

Response headers

cache-control: no-cache, no-store, max-age=

```

Once the success response is received, the target is validated and ready for use.

Flexera One

Turbonomic integrates its management of workloads with Flexera One License Management. To do this, Turbonomic discovers the licenses and entitlements that you have configured in your Flexera environment. Turbonomic then creates groups and policies to represent these licenses and entitlements.

- For each license, Turbonomic creates a dynamic group.

These groups contain the entities that are affected by a Flexera license. For example, Turbonomic might create one group of all the VMs affected by a license, and another group of all the host machines affected by that license.

These groups are dynamic – If you allocate or remove entities (workloads, hosts, etc.) under a given license, Turbonomic adds or removes those entities in the given group. Even if you have a license with no entities allocated to it, Turbonomic creates an empty group for that license.

The name of each group begins with Flexera. The group name then includes the name of the license, plus the entity type. For example, you might see the groups, Flexera: Microsoft SQL Server 2016 Standard VMs and Flexera: Microsoft SQL Server 2016 Standard Hosts.

- For supported licenses, Turbonomic creates Placement and Automation policies.

A Flexera license can include placement constraints, or resource utilization constraints. Turbonomic can create policies to comply with those constraints:

- Placement Policies

When calculating workload placement, Turbonomic uses placement policies to comply with constraints such as keeping workloads on licensed hosts, or clearing unlicensed workloads off of licensed hosts when necessary.

For more information, see [Placement Policies](#)

– Automation Policies

Among other settings, these policies can specify operational, utilization, and scaling constraints to match the constraints in your Flexera license policies.

For more information, see [Automation Policies](#)

The name for each policy begins with the name Flexera. The policy name then includes the name of the license and constraint. For example, you might see a policy named Flexera: Microsoft SQL Server 2016 Standard restrict to hosts.

Turbonomic then applies these policies to the groups that correspond to the entity type and license name.

Turbonomic Policies for Flexera Licenses

Turbonomic generates policies to comply with the following types of Flexera licenses, where **Usage Rights** lists the configurations Turbonomic considers when creating policies:

License:	Usage Rights:	Notes:
Microsoft Server Processor	Datacenter Edition <pre>"coverInstallsOnVirtualMachines": true, "limitNumberOfVirtualInstalls": false, "limitVirtualInstallsIncludesHost": true, "numberOfAllowedVirtualInstalls": 1</pre>	Create Placement Policies that limit on-prem VM moves to the licensed host.
	Standard Edition <pre>"coverInstallsOnVirtualMachines": true, "limitNumberOfVirtualInstalls": true, "limitVirtualInstallsIncludesHost": false, "numberOfAllowedVirtualInstalls": 1</pre>	Create Placement Policies that disable VM move actions.
Microsoft Server/ Management Core	Datacenter Edition <pre>"coverInstallsOnVirtualMachines": true, "limitNumberOfVirtualInstalls": false, "limitVirtualInstallsIncludesHost": false</pre>	Create Placement Policies that limit on-premise VM moves to the licensed host.
	Standard Edition <pre>"coverInstallsOnVirtualMachines": true, "limitNumberOfVirtualInstalls": true, "limitVirtualInstallsIncludesHost": false, "minimumNumberOfProcessors": 2</pre>	Create Placement Policies that disable VM move actions.

License:	Usage Rights:	Notes:
Microsoft Server Core	<pre>"coverInstallsOnVirtualMachines": false, "limitNumberOfVirtualInstalls": false, "limitVirtualInstallsIncludesHost": true, "minimumNumberOfThreadsPerVM": 4</pre>	<p>Turbonomic analysis assumes licensing is based on the host.</p> <p>Create Placement Policies that limit on-prem VM moves to the licensed host. Respect minimum vCPU thresholds.</p> <p>If there is a value for <code>minimumNumberOfThreadsPerVM</code>, create Automation Policies to enforce that minimum vCPU threshold for VMs.</p>

Flexera Permissions

The account that Turbonomic uses to connect with a Flexera target must be a Read-Only account with the following roles:

- View IT assets
- call APIs

Adding Flexera Targets

You can configure a target to a Flexera SaaS account. To add a Flexera target, select the **Orchestration > Flexera** option on the Target Configuration page and provide the following information:

- Flexera Region

The region for your Flexera account. Choose one of:

 - NAM
 - EU
- Organization ID

The unique identifier that defines your organization within Flexera One.
- Refresh Token

The credential that Turbonomic can use to generate Access Tokens as needed.
- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the Flexera instance via a proxy.
- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.
- Proxy Username

The username to use with the proxy specified above.
- Proxy Password

The password to use with the proxy specified above.
- Secure Proxy Connection

When checked, Turbonomic will connect to the proxy via HTTPS.

Actions

Turbonomic does not generate unique actions for entities it discovers through a Flexera target. Instead, it uses the license specifications it discovers in Flexera to prevent actions that do not comply with license restrictions. It can also modify or generate actions to ensure license compliance.

When Turbonomic generates an action, the action details include a list of policies that constrain the action recommendation. In this list, policy names that begin with `Flexera:` indicate policies that implement the license constraints Turbonomic has discovered for Flexera. You can click to navigate to the policy definition. Note that you cannot see the policy definition, but you cannot edit it.



The policies that Turbonomic generates affect Turbonomic actions in the following ways:

Entity:	Policy Impact on Actions:
Virtual Machine	<ul style="list-style-type: none"> Resize vCPU <p>Limit Resize actions to stay above a specified minimum.</p> <p>Turbonomic will not recommend a resize that falls below a specified minimum. However, if a VM is already below the specified minimum and shows no performance problems, it will not recommend a resize up.</p> Move <p>Turbonomic restricts licensed VMs to their matching licensed Hosts. If the host has capacity, it can move unlicensed VMs onto a licensed host. However, if the host sees bottlenecks, Turbonomic will move unlicensed VMs off of the host first.</p> <p>Move actions can also consolidate license consumption on hosts. Assume you have one host that supports two licenses (LA and LB), and another host that only supports one license (LA). Also assume a mix of workloads, some that require both LA and LB, and some that only require LA. Move actions can consolidate the LA workloads on the LA host, leaving more resources for workloads that also require LB.</p>
Host	<ul style="list-style-type: none"> Provision Host <p>Turbonomic can recommend to provision a new licensed host. For example, assume your environment includes hosts that support two different licenses (LA and LB). Now assume</p>

Entity:	Policy Impact on Actions:
	<p>you add more workloads that require only LB licenses. Turbonomic can recommend that you provision a new host that supports the LB license.</p> <ul style="list-style-type: none"> • Reconfigure Host <p>Turbonomic can recommend Host Reconfigure actions to change the licensing on a host. Assume Turbonomic has executed actions to consolidate LB-only workloads on a host with LA and LB licenses. Turbonomic can recommend that you reconfigure that host to remove LA, and only support the LB license.</p>

ServiceNow

You can configure Turbonomic policies that log Turbonomic actions in your ServiceNow instance, and that submit actions for approval in ServiceNow workflows.

For more information concerning orchestration, see [Action Orchestration](#).

Note:

When creating the action orchestration policy as explained in the section above, the scope of the policy must match the scope of the ServiceNow target.

Prerequisites

- A ServiceNow user with the `web_service_admin` role and the custom role `x_turbo_turbonomic.user` that is created during installation that can communicate with Turbonomic via the REST API.

Adding ServiceNow Targets

To add ServiceNow targets, select the **Orchestration > ServiceNow** option on the Target Configuration page and provide the following information:

- Address

Hostname of the ServiceNow instance without the `http` or `https` protocols. For example, `dev-env-266.service-now.com`.
- Username

Username for the account Turbonomic will use to connect to the ServiceNow instance
- Password

Password for the account Turbonomic will use to connect to the ServiceNow instance
- Client ID

The Client ID Turbonomic will use if Use `oAuth` is checked
- Client Secret

The password Turbonomic will use if Use `oAuth` is checked
- Port

Port used to access the ServiceNow Instance
- Use `oAuth`

When checked, Turbonomic will use `oAuth` authentication to connect to the ServiceNow target
- Proxy Host

IP address of the proxy server
- Proxy Port

Port used to access the proxy

- Proxy User

Username for the account Turbonomic will use to connect to the proxy

- Port

Port used to access the ServiceNow Instance

ServiceNow Integration

In order to complete target addition, see the [Turbonomic Actions for ServiceNow](#) documentation.

Private Cloud

A private cloud manages resources in pools to support multi-tenancy and self-service provisioning of virtual workloads. Turbonomic manages these resource pools in real time as demand fluctuates. This includes demand across resource pools, virtual datacenters (VDCs), and tenants.

Adding a Private Cloud target to Turbonomic aids in the goal of Application Resource Management (ARM) by preventing bottlenecks within and between your managed entities, resizing virtual machines and containers, prioritizing managed workloads, and reducing storage latency throughout your private cloud, ensuring that applications running in your private cloud always have the resources they need to perform, when they need to perform.

On the private cloud, you can use Turbonomic to:

- Set up charge-back and show-back for private cloud or service-provider scenarios
- For service-providers, set up scoped views to limit exposure to the customer base
- Plan hardware requirements — the planning scenarios takes cloud architectures into account

Supply Chain

For private clouds, Turbonomic discovers resource partitions that are managed by the cloud manager, the workloads running on these partitions (the VMs and applications), and the supply that hosts workload (the physical machines and storage). Turbonomic represents these partitions as the following types of Virtual Datacenters (VDCs):

- Provider VDC

A collection of physical resources (PMs and datastores) within a private cloud. The cloud administrator has access to these resources, and defines the datacenter members. Administrators allocate Provider VDCs to manage resources that will be allocated to external customers through one or more Consumer VDCs.

- Consumer VDC

A collection of resources that are available for customers to perform self-service management of workload through the cloud. It is an environment customers can use to store, deploy, and operate virtual systems. Consumer VDCs use the resources supplied by a Provider VDC.

Note:

Different targets use different names to refer to Virtual Datacenters. In the Turbonomic supply chain, these entities are all represented by Consumer and Provider VDCs, as follows:

Turbonomic	vCloud Director	vCenter Server	VMM
Consumer VDC	Organization VDC	Resource Pool (Child)	Tenant or TenantQuota
Provider VDC	Provider VDC	Resource Pool (Root)	Cloud

Actions

Turbonomic recommends actions for private cloud infrastructures as follows:

Provider Virtual Datacenters

Turbonomic does not recommend actions to perform on a Provider VDC. Instead, it recommends actions to perform on the devices running in the datacenter.

Consumer Virtual Datacenters

- Resize Consumer vDC
- Provision Consumer vDC

Monitored Resources

Turbonomic monitors the following private cloud infrastructure resources:

Provider Virtual Datacenter

- Memory (Mem)
The utilization of the Datacenter's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the Datacenter's CPU reserved or in use
Measured in Megahertz (MHz)
- Storage
The utilization of the storage attached to the Provider vDC.
Measured in Kilobytes (KB)

Consumer Virtual Datacenter

- Memory (Mem)
The utilization of the Datacenter's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the Datacenter's CPU reserved or in use
Measured in Megahertz (MHz)
- Storage
The utilization of the storage attached to the Consumer vDC.
Measured in Kilobytes (KB)

Virtual Machine Manager

In a VMM environment, the VMM management server processes commands and controls communications with the Hyper-V hosts. To manage VMM, you set the management server as a target. Turbonomic communicates with that target, and also with the Hyper-V hosts that the VMM server manages. For this reason, if you add a VMM target, you should not also add individual Hyper-V hosts as targets. You must grant Turbonomic access to the VMM management server, and also to all the associated Hyper-V machines.

Prerequisites

- VMM Dynamic Optimization disabled (recommended) or set to Low aggressiveness, with a frequency of at least 60 minutes.

- Configure remote management on the VMM management Hyper-V server. Refer to [Enabling Windows Remote Management](#)
- Grant access on every host in the cluster that Turbonomic will manage to the following WMI namespaces and subspaces:
 - root/virtualization
 - root/virtualization/v2
 - root/microsoft/windows/storage
 - root/microsoft/windows/smb
 - root/wmi
 - root/cimv2
 - root/mscluster
- Apply necessary hot fixes on the VMM host

For example, if you are running VMM Server on a Windows Server version earlier than Windows Server 2012 R2, you must apply the hot-fix referenced in the Microsoft Knowledge Base article #2842230 (<http://support.microsoft.com/kb/2842230>).
- Apply time synchronization

The VM that hosts Turbonomic must be synchronized with each target VMM management server. The Turbonomic Installation Guide includes instructions for synchronizing the clock on the Turbonomic server.
- PowerShell execution must be enabled on the VMM management server.
- Configure port access

WinRM uses ports 5985 and 5986 for standard and secure communications, respectively. The firewall on your VMM server must open these ports.
- Preexisting Hyper-V Targets

If any of the hosts that make up the VMM target were added separately as Hyper-V targets (and you do not plan to exclude these hosts), these targets must be deleted. Failure to do so will create duplicate entities in the market, which will negatively impact Turbonomic performance.

Adding VMM Targets

Turbonomic uses the address and credentials you provide to discover the VMM target. From the VMM target, Turbonomic gets the list of managed Hyper-V instances. It then uses that list to discover each Hyper-V instance. The Hyper-V credentials you provide must be valid for all of these machines.

Turbonomic will also import your Availability Sets, representing them as placement policies for the affected infrastructure.

To add VMM targets, select the **Private Cloud > VMM** option on the Target Configuration page, and provide the following information:

- The IP address or host name of the VMM management server
- Which port to use for the WSMAN connection

For a standard connection (HTTP) use 5985. For a secure connection (HTTPS) use 5986.
- Enable or disable a secure connection

If you enable a secure connection, then you must configure a certificate, and you must configure Turbonomic to communicate over HTTPS. For more information, see [Secure Setup for WSMAN](#).

Note that setting a secure connection for VMM does not also set secure connections for the underlying Hyper-V hosts. Any communications between Turbonomic and VMM will be secure. To configure secure connections to the underlying Hyper-V hosts, you must specify secure connections on each one.

- Full domain name for the user account

This domain name identifies the user account for Active Directory authentication.

- Login credentials for the Hyper-V servers that are managed by the VMM target (Optional)

Turbonomic must log into the Hyper-V servers that the VMM server manages. If you leave the Hyper-V credentials blank, then it will use the same credentials that VMM uses. If you provide Hyper-V credentials, then it will use that service account to log into every Hyper-V managed by the VMM.

Note that the service account Turbonomic uses to log into a Hyper-V host must satisfy certain requirements. For more information, see [Creating a Service User Account in Hyper-V](#).

- Hosts in the VMM target that you would like to exclude from Turbonomic.

Turbonomic will not discover or manage any hosts you enter in this field. These hosts do not participate in the market, and Turbonomic does not generate actions that involve these hosts. Enter multiple hosts in a comma-separated list. This field accepts both host names, and FQDNs (Fully Qualified Domain Names), and allows the use of the wild-card characters * and ?.

Microsoft VMM and Hyper-V VLANs

Windows Server Hyper-V provides support for VLANs on host and VM partitions. If your Hyper-V environment makes use of this VLAN support, then your VM moves must be sensitive to which hosts provide networking access to your defined VM networks. If a VM is a member of a given VM network, then any move of that VM must be to a host that has access to the same network.

For Hyper-V targets in a VMM environment, the Cloud Control Module is aware of the VM networks, and ensures that a move is to a host that provides connectivity over the given VM network. For example, if Host 1 and 2 provides connectivity to VM Network A, and Host 3 and 4 provide connectivity to VM Network B, Turbonomic will never recommend a VM with access to Network A, residing on Host 1, to move to Host 3. That would render the VM unable to communicate on Network A.

Configuring SMB 3.0 File Shares Discovery

With VMM, Turbonomic can discover SMB 3.0 shares as datastores, assuming these shares have been properly added to your VMM service center. When you add shares to your VMM environment, be sure to:

- Use the Fully Qualified Domain Name of the file server

As you add the associated file server to your VMM environment (via the Add Storage Devices Wizard), be sure to specify the FQDN of the file server on the Specify Discovery Scope page of the wizard. Do not use the file server's IP address.

- Ensure that file server names are unique

Do not specify file servers with the same name, even if they belong to different domains. Turbonomic requires the file server names to be unique.

For information about setting up SMB 3.0 shares, please refer to your Microsoft documentation. For example, see [“How to Assign SMB 3.0 File Shares to Hyper-V Hosts and Clusters in VMM”](#).

Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

Virtual Machines

- Provision additional resources (VMem, VCPU)
- Move Virtual Machine
- Move Virtual Machine Storage
- Reconfigure Storage
- Reconfigure Virtual Machine
- Suspend VM
- Provision VM

Physical Machines

- Start Physical Machine
- Provision Physical Machine
- Suspend Physical Machine

Consumer Virtual Datacenters

- Resize Consumer vDC
- Provision Consumer vDC

Monitored Resources

Turbonomic monitors the following resources for the cloud target supply chain:

Virtual Machine

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Host

- Memory (Mem)
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- IO
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- Net
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- Swap
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- Balloon
The utilization of shared memory among VMs running on the host. ESX-only

Measured in Kilobytes (KB)

- CPU Ready

The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only

Measured in Megahertz (MHz)

Datacenter

Note: For datacenter entities, Turbonomic does not monitor resources directly from the datacenter, but from the physical machines in the datacenter.

- Memory (Mem)

The utilization of the PM's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the PM's CPU reserved or in use

Measured in Megahertz (MHz)

- IO

The utilization of the PM's IO adapters

Measured in Kilobytes per second (KB/s)

- Net

The utilization of data through the PM's network adapters

Measured in Kilobytes per second (KB/s)

- Swap

The utilization of the PM's swap space

Measured in Kilobytes (KB)

- Balloon

The utilization of shared of memory among VMs running on the host. ESX-only

Measured in Kilobytes (KB)

- CPU Ready

The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only

Measured in Kilobytes (KB)

Provider Virtual Datacenter

- Memory (Mem)

The utilization of the Datacenter's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the Datacenter's CPU reserved or in use

Measured in Megahertz (MHz)

- Storage

The utilization of the storage attached to the Provider vDC.

Measured in Kilobytes (KB)

Consumer Virtual Datacenter

- Memory (Mem)
The utilization of the Datacenter's memory reserved or in use
Measured in Kilobytes (KB)
- CPU
The utilization of the Datacenter's CPU reserved or in use
Measured in Megahertz (MHz)
- Storage
The utilization of the storage attached to the Consumer vDC.
Measured in Kilobytes (KB)

Public Cloud

The public cloud provides compute, storage, and other resources on demand. By adding an AWS Billing Target (AWS) or Microsoft Enterprise Agreement (Azure) to use custom pricing and discover reserved instances, you enable Turbonomic to use that richer pricing information to calculate workload size and RI coverage for your Azure environment.

You can run all of your infrastructure on a public cloud, or you can set up a hybrid environment where you burst workload to the public cloud as needed. Turbonomic can analyze the performance of applications running on the public cloud, and provision more instances as demand requires. For a hybrid environment, Turbonomic can provision copies of your application VMs on the public cloud to satisfy spikes in demand, and as demand falls off it can suspend those VMs if they're no longer needed.

With public cloud targets, you can use Turbonomic to:

- Scale VMs and Databases
- Change storage tiers
- Purchase VM Reservations
- Locate the most efficient workload placement within the hybrid environment, while assuring performance
- Detect unused storage volumes

Cloud-based datacenters support scalability, resource pooling, multi-tenancy, and self-service management of virtual resources. Turbonomic supports the following cloud technologies:

Supply Chain

For public clouds, Turbonomic discovers Regions and Zones. Regions and zones divide the public cloud into managed subsets. A region is typically associated with the geographic location of the cloud resources, and a zone is some division within the region. One region contains multiple zones.

Amazon Web Services

Amazon Web Services (AWS) provides a reliable and scalable infrastructure platform in the cloud. You gain access to this infrastructure through a subscription account with the appropriate organization API permissions. To specify an AWS target, you provide the credentials for that account and Turbonomic discovers the resources available to you through that account.

In order to discover RI utilization, you must provide Turbonomic with access to the S3 bucket that contains the AWS Cost and Usage report. Without this access, Turbonomic's purchase and scale decisions will be made without consideration of this data.

In order to discover all RIs in an AWS billing family, you must add a billing target via the master account. This master account needs cost explorer API access. Without the master account, Turbonomic will discover only those RIs that are purchased by accounts which have been added as targets.

AWS GovCloud Targets

When adding GovCloud targets, ensure the following prerequisites are met:

- The GovCloud account must be either a master account with organization access, or a member account belonging to a master account already added to Turbonomic.
- A billing target with organization access containing billing information for the GovCloud target must be added to Turbonomic in order to see RI information.

RI utilization information is identical to non-government targets as outlined above.

- Each account within the organization must have a unique name.

Optionally, you can add the AWS standard account that manages invoicing for a GovCloud account. When you add this standard account, it appears in the Top Accounts chart and shows the total projected billed cost for the GovCloud account and the standard account itself.

Supported Regions – AWS

Turbonomic supports discovery and management of entities in the following AWS regions:

Region Code	Region Name	Notes
af-south-1	Africa (Cape Town)	Requires Opt-In within AWS console
ap-south-1	Asia Pacific (Mumbai)	
ap-northeast-2	Asia Pacific (Seoul)	
ap-southeast-1	Asia Pacific (Singapore)	
ap-northeast-1	Asia Pacific (Tokyo)	
ap-southeast-2	Asia Pacific (Sydney)	
ap-east-1	Asia Pacific (Hong Kong)	Requires Opt-In within AWS console
ap-northeast-3	Asia Pacific (Osaka)	
ca-central-1	Canada (Central)	
eu-central-1	Europe (Frankfurt)	
eu-south-1	Europe (Milan)	Requires Opt-In within AWS console
eu-west-1	Europe (Ireland)	
eu-west-2	Europe (London)	
eu-west-3	Europe (Paris)	
eu-north-1	Europe (Stockholm)	
me-south-1	Middle East (Bahrain)	Requires Opt-In within AWS console
sa-east-1	South America (São Paulo)	
us-east-1	US East (N. Virginia)	
us-east-2	US East (Ohio)	
us-west-1	US West (N. California)	
us-west-2	US West (Oregon)	

Region Code	Region Name	Notes
us-gov-east-1	AWS GovCloud (US-East)	Restricted Access (GovCloud)
us-gov-west-1	AWS GovCloud (US-West)	Restricted Access (GovCloud)

Adding AWS Targets

For Turbonomic to manage an AWS account, you provide the credentials via the access key or IAM role that you use to access that account. For information about getting an Access Key for an AWS account, see the Amazon Web Services documentation.

The AWS Target has different target addition requirements based on connection via key or IAM role.

To add an AWS target *without* an IAM Role, specify the following:

- Custom Target Name

The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

- GovCloud toggle

When enabled, this target will be added as an AWS GovCloud (US) target.

- Access Key

Provide the **Access Key** for the account you want to manage.

- Secret Access Key

Provide the **Access Key Secret** for the account you want to manage.

- Proxy Host

The IP of your Proxy Host

- Proxy Port

The port required for the proxy above

- Proxy User

The username required for the proxy above

- Proxy Password

The password required for the proxy above

To add an AWS target *with* an IAM Role, specify the following:

Note:

Turbonomic does not support adding AWS targets via IAM roles for an instance that was deployed on-prem as an OVA or VHD image. If your instance was deployed in this way, you must add the target *without* using IAM roles (see above).

We recommend that you set up IAM access via an IAM group that has the necessary permissions. After you create this group, create a user that is a member of it and specify that user for Turbonomic to access your AWS environment. For more information about IAM Groups, see <http://docs.aws.amazon.com/IAM/latest/UserGuide/best-practices.html>.

For more information about adding targets via IAM roles, see <https://support-turbonomic.force.com/TurbonomicCustomerCommunity/s/article/Turbonomic-SaaS-IAM-Role-Setup>

- Custom Target Name

The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

- IAM Role ARN

Provide the **ARN** for the IAM role used to access the AWS billing information.

- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the internet via a proxy.

- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.

- Proxy Username

The username for the account to log into the proxy specified above.

- Proxy Password

The password to use with the proxy specified above.

Firewall and Proxy Access

If you run Turbonomic behind a proxy or firewall, then you must configure Turbonomic to allow unrestricted access to the following URLs. This enables the full set of features for AWS targets.

Note:

If your firewall performs IP based routing, be aware that Amazon reserves the right to change the DNS names on these endpoints over time. Also note, the AWS SDK is designed to use dynamic endpoints. It is possible that Amazon will change the endpoints the SDK depends on over time. As a result, the names of endpoints you must access might be different than the names listed here.

- Autoscaling

`autoscaling.{region-id}.amazonaws.com`

- AWS Bill

`{bucket-name}.s3.{region-containing-report}.amazonaws.com`

- CloudWatch

`monitoring.{region-id}.amazonaws.com`

- CloudWatch Events

`events.{region-id}.amazonaws.com`

- CloudWatch Logs

`logs.{region-id}.amazonaws.com`

- Cost Explorer

`ce.us-east-1.amazonaws.com`

- EC2

`ec2.{region-id}.amazonaws.com`

- Elastic Load Balancing

`elasticloadbalancing.{region-id}.amazonaws.com`

- IAM

`iam.amazonaws.com`

- Organizations

`organizations.{region-id}.amazonaws.com`

- Performance Insights

`pi.{region-id}.amazonaws.com`

- Price List

`pricing.us-east-1.amazonaws.com`

- Relational Database Service (RDS)
`rds.{region-id}.amazonaws.com`
- Resource Groups
`resource-groups.{region-id}.amazonaws.com`
- Savings Plans (Optional: Required if you use Savings Plans in your environment)
`savingsplans.amazonaws.com`
- Service Catalog
`servicecatalog.{region-id}.amazonaws.com`
- S3
`s3.{region-id}.amazonaws.com`
- Storage Gateway
`storagegateway.{region-id}.amazonaws.com`

Whitelisting AWS Regions

While Turbonomic is discovering your AWS environment, if it fails to reach one or more AWS regions, then AWS discovery will fail for that target.

There may be policy decisions that prevent Turbonomic from reaching all AWS regions. For example, if you operate Turbonomic behind a firewall, you might not be able to reach all the regions that are available to your AWS account. In that case, you need to specify which regions you want Turbonomic to discover.

For information about how to specify the regions that you want Turbonomic to discover, contact your support representative.

Cost and Usage Report

In order for Turbonomic to display month-to-day spend, you must create a cost and usage report in AWS and store it in an S3 bucket. For more information, see:

- [Creating Cost and Usage Reports in the AWS documentation](#)
- [Setting up an Amazon S3 bucket for Cost and Usage Reports in the AWS documentation](#)
- [Displaying AWS Spend In Turbonomic.](#)

Enabling Collection of Memory Statistics

We highly recommend enabling collection of memory metrics in your AWS environment. With memory metrics, Turbonomic can generate actions that not only boost performance but also maximize your savings.

For Turbonomic to collect memory statistics in AWS, you must set up CloudWatch to enable the collection of these statistics on the VMs in your environment. For more information, see [Enabling Collection of Memory Statistics: AWS](#).

AWS Permissions

The account for an AWS target must have permissions that enable Turbonomic to monitor entities in your environment, recommend actions, and execute actions.

Generic Permissions

You can use generic AWS permissions to set up access for the account Turbonomic uses to access your target. This is an easy way to configure a target account, but you do not have full control over the access you grant to that account. For finer control, you should set the minimum permissions.

Permission Level	Required Permissions
Read-Only (monitoring and recommendations)	<ul style="list-style-type: none"> • AmazonEC2ReadOnlyAccess • AmazonS3ReadOnlyAccess • AmazonRDSReadOnlyAccess • AWSConfigRoleForOrganizations (only required for consolidated billing with the master account)
Execute Actions	<ul style="list-style-type: none"> • AmazonEC2FullAccess • AmazonS3ReadOnlyAccess • AmazonRDSFullAccess • AWSConfigRoleForOrganizations (only required for consolidated billing with the master account)

Minimum Permissions

To explicitly control the access that you grant to Turbonomic, as a minimum the account for an AWS target must have the following permissions:

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none"> • autoscaling:DescribeAutoScalingGroups • cloudwatch:GetMetricData • cloudwatch:GetMetricStatistics • cloudwatch:ListMetrics • ec2:DescribeSpotInstanceRequests • ec2:DescribeAvailabilityZones • ec2:DescribeInstances • ec2:DescribeImages • ec2:DescribeVolumes • ec2:DescribeVolumeStatus • ec2:DescribeVolumesModifications • ec2:DescribeAddresses • ec2:DescribeRegions • ec2:DescribeReservedInstances • ec2:DescribeReservedInstancesModifications • ec2:DescribeSpotPriceHistory • ec2:DescribeAccountAttributes • elasticloadbalancing:DescribeTargetGroups • elasticloadbalancing:DescribeTargetHealth • elasticloadbalancing:DescribeLoadBalancers • elasticloadbalancing:DescribeInstanceHealth • iam:GetUser • organizations:DescribeOrganization • organizations:ListAccounts • pi:GetResourceMetrics

Turbonomic Functionality	Required Permissions
	<ul style="list-style-type: none"> • rds:DescribeDBInstances • rds:DescribeDBClusters • rds:DescribeDBParameters • rds:ListTagsForResource • rds:DescribeOrderableDBInstanceOptions • servicecatalog:SearchProducts
Action Execution	<ul style="list-style-type: none"> • autoscaling:SuspendProcesses • autoscaling:ResumeProcesses • autoscaling:DescribeLaunchConfigurations • autoscaling>CreateLaunchConfiguration • autoscaling>DeleteLaunchConfiguration • autoscaling:UpdateAutoScalingGroup • ec2:DescribeInstances • ec2:DescribeVolumes • ec2:DescribeVolumesModifications • ec2:ModifyInstanceAttribute • ec2:StopInstances • ec2:StartInstances • ec2:ModifyVolume • ec2:DescribeInstanceStatus • ec2:DescribeReservedInstancesOfferings • ec2>DeleteVolume • KMS:CreateGrant (required if your EC2 instances use encrypted ECB volumes) • rds:ModifyDBInstance • servicecatalog:DescribeProduct • servicecatalog:ProvisionProduct • servicecatalog:DescribeRecord • servicecatalog:ListLaunchPaths
Savings Plans	<ul style="list-style-type: none"> • savingsplans:DescribeSavingsPlans

To enable access to an AWS Billing target, the account must also include these permissions (see [AWS Billing Targets](#)):

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none"> • ce:GetReservationUtilization • ce:GetSavingsPlansUtilizationDetails • ce:GetSavingsPlansUtilization • ce:GetSavingsPlansCoverage • iam:GetUser • organizations:DescribeOrganization

Turbonomic Functionality	Required Permissions
	<ul style="list-style-type: none"> • organizations:ListAccounts • s3:GetBucketAcl • s3:GetObject • sts:AssumeRole • sts:AssumeRoleWithWebIdentity

Cloud Instance Family Support

You can see the cloud instance families that Turbonomic manages in the User Interface:

- Navigate to **Settings > Policies > Virtual Machines Defaults**
- In that policy, add **Scaling Constraint** and choose **Cloud Instance Types**
- Click **Edit**

The policy page shows lists of supported Cloud instance types for each clout provider.

Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

• Virtual Machine

– Scale

Change the VM instance to use a different instance type or tier to optimize performance and costs.

– Increase RI Coverage / Buy RI

If you have a high percentage of on-demand VMs, you can reduce your monthly costs by increasing coverage. To increase coverage, you scale VMs to instance types that have existing capacity. If you need more RI capacity, then Turbonomic will recommend Buy RI actions.

For details, see [Cloud VM Actions](#).

• Database Server

Scale

Scale compute and storage resources to optimize performance and costs.

For details, see [Cloud Database Server Actions](#).

• Volume

– Scale

Scale attached volumes to optimize performance and costs.

– Delete

Delete unattached volumes as a cost-saving measure.

For details, see [Cloud Volume Actions](#).

Monitored Resources

Turbonomic monitors the following resources for the cloud target supply chain:

Virtual Machine (AWS)

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

Measured in Kilobytes (KB)

- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)
- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS
- Net Throughput
Rate of message delivery over a port
Measured in KB/s
- Net Throughput Inbound
Rate of message received over a port
Measured in KB/s
- Net Throughput Outbound
Rate of message sent over a port
Measured in KB/s
- I/O Throughput
The throughput to the underlying storage for the entity
Measured in KB/s
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

Database Server

- Virtual Memory (VMem)
The utilization of VMem allocated to the Database Server's instance type
- Virtual CPU (VCPU)
The utilization of VCPU allocated to the Database Server's instance type
- Storage Amount
The amount of Amazon EBS storage utilized by the Database Server
- Storage Access
IOPS utilized by the Database Server
- DB Cache Hit Rate (if available)
The percentage of database responses served through cache hits
- Connections
The number of connections to the Database Server

Volume

- Storage Access

The percentage of the volume's capacity for storage access operations (measured in IOPS) that is in use.

- IO Throughput

The percentage of the volume's capacity for IO throughput (measured in MB/s) that is in use.

- IO Throughput Read

The percentage of the volume's capacity for IO throughput Read (measured in MB/s) that is in use.

- IO Throughput Write

The percentage of the volume's capacity for IO throughput Write (measured in MB/s) that is in use.

AWS Billing Families

As you configure AWS targets, Turbonomic discovers AWS accounts that are consolidated into *billing families*. A billing family has one *master* account, and zero or more *member* accounts. By recognizing billing families, Turbonomic more accurately calculates cloud investments and savings, and makes more accurate recommendations for RI coverage.

In the Targets user interface, master accounts appear in bold, with a star next to them. You can expand the account entry to see the related member accounts. If you expand the entry for a member account, then the related accounts includes the family master, indicated by a star.

For RI purchases, different accounts in a billing family can share the same RI resources. At the same time, accounts in other billing families cannot use those RIs. This adds flexibility to your RI coverage, while maintaining order over the billing.

In Turbonomic, if you enable Billing Family Recognition, then you can see the billing family master and member accounts in the Targets user interface, and Turbonomic can recommend proper RI purchases within the correct billing families.

To enable Billing Family Recognition, ensure the following as you configure your AWS targets:

- Use the proper role for each AWS target

To properly discover billing family information for a target, you must give Turbonomic credentials for an AWS role that includes the permission, `organizations:DescribeOrganization`. With that permission, Turbonomic can:

- Discover master accounts and member accounts in different billing families
- Display the account names in the user interface
- Discover billing information for each family and account
- Recommend RI actions that respect billing family boundaries

- Configure targets for the complete billing family

One billing family can consolidate a number of AWS accounts. For Turbonomic to include these accounts in its analysis, you must configure each one as a separate target. If you do not configure all the accounts in a billing family, then Turbonomic cannot discover complete billing information for that family, and its analysis will be based on incomplete information.

Turbonomic displays member accounts that have been configured as targets in regular text. For members that Turbonomic discovers but have not been configured as targets, Turbonomic displays their names in grayed text.

If you have enabled Billing Family Recognition, you should keep the following points in mind:

- Billing families can grow

Turbonomic regularly checks the membership of your billing families. If it discovers a new member account, it adds that account to the list of members. If you have already configured the account as a target, then Turbonomic includes the new member in its analysis of billing families. If the new member is not already a target, then Turbonomic lists the new member in grayed text.

- You can configure discounts per billing family

Turbonomic includes a feature to set a discount for a billing group, and to override that discount for specific template families within that scope. For more information, see [Cloud Discounts](#) and [Discount Override: AWS](#).

- You might see master accounts that have no member accounts

AWS treats every account you create as a part of a billing family. Assume you created an account, but you had no reason to consolidate its billing with any other accounts. In that case, the account appears in the Turbonomic user interface as a master account, but it has no member accounts.

AWS Billing Targets

The Turbonomic AWS Billing target allows users to grant access to a bill which is used to discover billing family relationships. It does not provide access to any operational concern of an AWS account. Note that you can have one AWS Billing target per Turbonomic instance.

Note:

Billing targets use Cost and Usage reports.

In order for Turbonomic to display month-to-day spend, you must create a cost and usage report in AWS and store it in an S3 bucket. For more information, see:

- [Creating Cost and Usage Reports](#) in the AWS documentation
- [Setting up an Amazon S3 bucket for Cost and Usage Reports](#) in the AWS documentation
- [Displaying AWS Spend In Turbonomic](#).

Adding an AWS Billing Target

The AWS Billing Target has different target addition requirements based on connection via key or IAM role.

To add an AWS Billing target *without* an IAM Role, specify the following:

- Custom Target Name
The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.
- Access Key
Provide the **Access Key** for the account you want to manage.
- Secret Access Key
Provide the **Access Key Secret** for the account you want to manage.
- Cost and Usage Report Bucket
Name of the S3 bucket that contains the AWS Cost and Usage report.
- Cost and Usage Report Path
Path in the S3 bucket to the AWS Cost and Usage report.
- Cost and Usage Report Region
Region of the S3 bucket that contains the AWS Cost and Usage report.
- Proxy Host
The address of the proxy used for this target. Only fill out proxy information if you connect to the Dynatrace server via a proxy.
- Proxy Port
The port to use with the proxy specified above. By default, this is 8080.
- Proxy Username
The username for the account to log into the proxy specified above.
- Proxy Password
The password to use with the proxy specified above.

To add an AWS Billing target *with* an IAM Role, specify the following:

- Custom Target Name
The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.
- IAM Role ARN
Provide the **ARN** for the IAM role used to access the AWS billing information.
- Cost and Usage Report Bucket
Name of the S3 bucket that contains the AWS Cost and Usage report.
- Cost and Usage Report Path
Path in the S3 bucket to the AWS Cost and Usage report.
- Cost and Usage Report Region
Region of the S3 bucket that contains the AWS Cost and Usage report.
- Proxy Host
The address of the proxy used for this target. Only fill out proxy information if you connect to the Dynatrace server via a proxy.
- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.

- Proxy Username

The username for the account to log into the proxy specified above.

- Proxy Password

The password to use with the proxy specified above.

AWS Billing Target Permissions

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none">• ce:GetReservationUtilization• ce:GetSavingsPlansUtilizationDetails• ce:GetSavingsPlansUtilization• ce:GetSavingsPlansCoverage• iam:GetUser• organizations:DescribeOrganization• organizations:ListAccounts• s3:GetBucketAcl• s3:GetObject• sts:AssumeRole• sts:AssumeRoleWithWebIdentity

Actions

Turbonomic does not recommend actions for AWS Billing targets. However, the billing information will be used in conjunction with the AWS target to make informed decisions.

Monitored Resources

Turbonomic does not monitor resources for AWS Billing targets. However, the billing information will be used in conjunction with the AWS target to make informed decisions.

Google Cloud Platform

Google Cloud Platform (GCP) provides a scalable infrastructure platform in the cloud. Turbonomic gains access to this infrastructure through a GCP [service account](#) with the appropriate permissions.

When you add a service account as a target, Turbonomic discovers the projects that define compute, storage, and networking resources for your workloads. It then creates a derived target for each discovered project. Derived targets are not directly modifiable within Turbonomic but can be validated like any other target.

Turbonomic discovers a broader resource hierarchy if you add a service account target with permissions to retrieve folders or your entire GCP organization.

Turbonomic uses cost data in its analysis to make accurate recommendations for your workloads. To enable cost discovery and monitoring, you must grant your service account "Billing Account Viewer" access to the related [billing accounts](#), and then add those billing accounts as targets.

Note:

When you add billing accounts, Turbonomic also discovers negotiated pricing and committed use discounts (CUD) for your workloads. Currently, analysis makes VM scaling recommendations based on existing CUD capacity. CUD purchase recommendations will be introduced in a future release.

Also, analysis does not recognize Prioritized attributes you have set for CUD. For example, if you have prioritized all your CUD allotments for a single project, Turbonomic analysis can still recommend actions to apply CUD to other projects in your environment.

Supported Regions and Zones

Turbonomic supports discovery and management of workloads in all currently available GCP [regions and zones](#).

Permissions

To configure GCP targets, you create service accounts with roles that grant Turbonomic the permissions it needs to discover your GCP resources and costs, and to execute actions (optional). This section lists the minimum permissions you need.

Note:

For instructions on creating service accounts in a `gcloud shell` session, see [GCP Target Service Account](#) and [GCP Billing Target Service Account](#).

Turbonomic Functionality	Minimum Authorization Scopes	Minimum IAM Roles/Permissions
(Required) Resource discovery	<i>Project-level scopes and permissions</i>	
	<p>One of the following scope sets:</p> <p>Set 1:</p> <ul style="list-style-type: none"> • https://www.googleapis.com/auth/cloudplatformprojects.readonly • https://www.googleapis.com/auth/cloud-platform • https://www.googleapis.com/auth/cloud-billing.readonly <p>Set 2:</p> <ul style="list-style-type: none"> • https://www.googleapis.com/auth/cloudplatformprojects.readonly • https://www.googleapis.com/auth/compute • https://www.googleapis.com/auth/monitoring.read • https://www.googleapis.com/auth/cloud-billing.readonly 	<ul style="list-style-type: none"> • <code>resourcemanager.projects.get</code> • <code>compute.regions.list</code> • <code>compute.zones.list</code> • <code>compute.machineTypes.list</code> • <code>compute.machineTypes.get</code> • <code>compute.disks.list</code> • <code>compute.disks.get</code> • <code>compute.diskTypes.list</code> • <code>compute.instances.list</code> • <code>compute.instances.get</code> • <code>compute.instanceGroupManagers.list</code> • <code>compute.instanceGroupManagers.get</code> • <code>logging.views.list</code> • <code>logging.views.get</code> • <code>monitoring.services.get</code> • <code>monitoring.services.list</code> • <code>monitoring.timeSeries.list</code>
	<p><i>Organization-level scopes and permissions</i></p> <p>Note:</p> <p>To target specific folders, define a custom role at the organization level. It is not possible to define custom roles at the folder level.</p>	
	<p>One of the following scope sets:</p> <p>Set 1:</p> <ul style="list-style-type: none"> • https://www.googleapis.com/auth/cloud-platform • https://www.googleapis.com/auth/cloud-billing.readonly <p>Set 2:</p> <ul style="list-style-type: none"> • https://www.googleapis.com/auth/cloud-platform.read-only • https://www.googleapis.com/auth/iam.test • https://www.googleapis.com/auth/cloud-billing.readonly <p>Set 3:</p> <ul style="list-style-type: none"> • https://www.googleapis.com/auth/cloudplatformorganizations.readonly • https://www.googleapis.com/auth/cloudplatformfolders.readonly 	<ul style="list-style-type: none"> • All project-level permissions • <code>resourcemanager.organizations.get</code> • <code>resourcemanager.folders.get</code> • <code>resourcemanager.folders.list</code> • <code>resourcemanager.projects.list</code> • <code>resourcemanager.projects.get</code> • <code>billing.resourceAssociations.list</code>

Turbonomic Functionality	Minimum Authorization Scopes	Minimum IAM Roles/Permissions
<p>(Required) Cost discovery</p> <p>Turbonomic discovers billing families, billed costs, negotiated pricing, and committed use discounts.</p>	<ul style="list-style-type: none"> • All project-level scopes • https://www.googleapis.com/auth/cloud-billing.readonly • One of the following scopes: <ul style="list-style-type: none"> – https://www.googleapis.com/auth/compute – https://www.googleapis.com/auth/cloud-platform 	<p>The service account should have the Billing Account Viewer role and the following permissions to the project that stores billing data:</p> <ul style="list-style-type: none"> • All project-level permissions • <code>billing.resourceAssociations.list</code> • <code>billing.accounts.list</code> • <code>compute.commitments.list</code> <p>For queries of billed costs and negotiated pricing via BigQuery, the service account should have the Billing Account Viewer role and the following permissions to the project that stores billing data:</p> <ul style="list-style-type: none"> • <code>bigquery.tables.get</code> • <code>bigquery.tables.getData</code> • <code>bigquery.tables.list</code> • <code>bigquery.jobs.create</code>
<p>(Optional) Action execution</p> <p>Currently, Turbonomic can execute actions for VMs.</p>	<ul style="list-style-type: none"> • All project-level scopes • One of the following scopes: <ul style="list-style-type: none"> – https://www.googleapis.com/auth/compute – https://www.googleapis.com/auth/cloud-platform 	<ul style="list-style-type: none"> • All project-level permissions • <code>compute.instances.stop</code> • <code>compute.instances.setMachineType</code> • <code>compute.instances.start</code> • <code>compute.zoneOperations.get</code> • <code>compute.regionOperations.get</code> • <code>compute.globalOperations.get</code>

Firewall Access

If you run Turbonomic behind a firewall, you must configure Turbonomic to allow unrestricted access to the following GCP URLs:

- <https://cloudresourcemanager.googleapis.com>
- <https://cloudbilling.googleapis.com>
- <https://compute.googleapis.com>
- <https://monitoring.googleapis.com>
- <https://bigquery.googleapis.com>

Enabling Collection of Memory Metrics

We highly recommend enabling collection of memory metrics in your GCP environment. With memory metrics, Turbonomic can generate actions that not only boost performance but also maximize your savings.

GCP collects these metrics via [Ops Agent](#). In order for Turbonomic to retrieve these metrics, you must install and configure Ops Agent on each VM that it monitors. See Ops Agent installation instructions [here](#), and configuration details [here](#).

Note:

GCP recommends using Ops Agent instead of its [legacy monitoring agent](#).

Enabling Required GCP APIs

For Turbonomic to discover your GCP environment and billing details, you must enable the following APIs:

- Cloud Resource Manager API
Creates, reads, and updates metadata for GCP resource containers.
- Compute Engine API
Creates and runs VMs on GCP.
- Cloud Billing API
Enables developers to manage billing for their GCP projects programmatically.
- BigQuery API
A data platform for customers to create, manage, share, and query data.

To enable these APIs:

1. Navigate the GCP Console to the library of APIs.

On the GCP Console home page, navigate to **APIs & Services > Library**.

2. Search for the API you want to enable.

In the API Library **Search** box, enter the name of the API you want to enable. Then press **Enter** to execute the search. Repeat these steps for each of:

- Cloud Resource Manager API
- Compute Engine API
- Cloud Billing API
- BigQuery API

3. Enable the given API.

In the list that appears, click the API name to navigate to that API page. If the API is not already enabled, click **Enable**.

After you enable the given API, the console displays a details page for that API.

4. Navigate to the console Home page.

For each API you want to enable, navigate back to the home page and repeat these steps.

Adding Service Accounts as Targets

Once a service account has been properly configured for use with Turbonomic, you must add it as a target from the Target Configuration page.

Specify the following when adding the target:

- Display Name
The name that identifies the target in Turbonomic. This name is for display purposes only and does not need to match any name in GCP.
- Service Account Key (JSON)
The [service account key](#) for the account you want to manage. Paste the JSON object for the account key into this field.

- Proxy Information

Specify proxy information only if you connect to a GCP target via proxy.

- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the AppDynamics instance via a proxy.

- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.

- Proxy Username

The username to use with the proxy specified above.

- Proxy Password

The password to use with the proxy specified above.

- Secure Proxy Connection

When checked, Turbonomic will connect to the proxy via HTTPS.

Adding Billing Accounts as Targets

To add a billing account target, specify the following:

- Target Name

The name that identifies the target in Turbonomic. This name is for display purposes only and does not need to match any name in GCP.

- Service Account Key

The [service account key](#) for the account associated with the billing account.

- GCP Project ID

The unique ID assigned to the project associated with the billing account. Costs accrued to this project are charged to the billing account you are adding.

- BigQuery Settings

BigQuery is a data warehouse that helps you manage GCP data. Turbonomic uses BigQuery resources to discover cost data for your environment. If you do not configure any of these fields, this target will not discover any cost data for Turbonomic analysis.

For information about BigQuery resources, see [Organizing BigQuery resources](#). For information about BigQuery tables, see [Example queries for Cloud Billing data export](#), [Schema of the standard usage cost data](#), [Schema of the detailed usage cost data](#), and [Schema of the pricing data](#)

To configure your target to discover BigQuery data, specify values for the following fields.

- BigQuery Cost Export Data Set Name

The data set for billed costs. After you specify a data set, you must also specify the corresponding BigQuery Cost Export Table Name.

You can find the data set name in the GCP Billing dashboard under **Billing export / BIGQUERY EXPORT**.

- BigQuery Cost Export Table Name

This is the table of exported cost data. You can find the table name in the GCP BigQuery Explorer. Expand your project, and then expand the Cost Export Data Set Name.

- Enable Resource-Level Detail From Cost Export Table

When you configure Billing Export, you can enable **Detailed usage cost**. To expose this detailed data to Turbonomic, turn on this option and then give the name of the detailed data table in the **BigQuery Cost Export Table Name** field. You can find the table name in the GCP BigQuery Explorer.

Note:

Only turn on this option if you have enabled **Detailed usage cost**. If you want to provide a **Standard usage cost** table, do not turn on this option.

- BigQuery Pricing Export Table Name

This field automatically populates with the table name used in BigQuery, `cloud_pricing_export`. You need to provide a different name if you do any of the following:

- Use a different table for negotiated pricing
- Specify a value for the **BigQuery Pricing Export Data Set Name** field. In that case, you must also specify the corresponding pricing export table.

- BigQuery Pricing Export Data Set Name

The data set for pricing. You can find the data set name in the GCP Billing dashboard under **Billing export / BIGQUERY EXPORT**.

- Billing Account ID

The identifier of the Billing Account you want to target. This field is required if you configure **BigQuery Pricing Export Data Set Name** and **BigQuery Pricing Export Table Name**.

- Proxy Information

Specify proxy information only if you connect to a GCP target via proxy.

- Proxy Host

The address of the proxy used for this target. Only fill out proxy information if you connect to the AppDynamics instance via a proxy.

- Proxy Port

The port to use with the proxy specified above. By default, this is 8080.

- Proxy Username

The username to use with the proxy specified above.

- Proxy Password

The password to use with the proxy specified above.

- Secure Proxy Connection

When checked, Turbonomic will connect to the proxy via HTTPS.

Cloud Instance Family Support

You can see the cloud instance families that Turbonomic manages in the User Interface:

- Navigate to **Settings > Policies > Virtual Machines Defaults**
- In that policy, add **Scaling Constraint** and choose **Cloud Instance Types**
- Click **Edit**

The policy page shows lists of supported Cloud instance types for each cloud provider.

Entity Mapping

After validating your GCP targets, Turbonomic updates the supply chain with the entities that it discovered. The following table describes the entity mapping between GCP and Turbonomic.

GCP	Turbonomic
Virtual Machine (VM) Instance	Virtual Machine (VM)

GCP	Turbonomic
	Note: Turbonomic discovers GCP labels attached to VMs as tags. You can filter VMs by tags when you use Search or create groups. The Action Details page for a pending VM action also lists all the discovered tags.
Storage/Disk (attached to VMs)	Volume
Zone	Zone
Region	Region

Note:

GCP *projects*, *folders*, and *billing accounts* do not appear as entities in the supply chain. Use Search to scope to these resources. In Search, projects are grouped under Accounts, folders under Folders, and billing accounts under Billing Families.

For billing accounts, the latest billing data available from Google is always a few days old. As a result, billing-related charts (such as the Billed Cost chart) do not have data for the current day.

Monitored Resources

Turbonomic monitors the following resources for GCP workloads:

Virtual Machine

Note:

Turbonomic does not monitor GCP machine types or CPU platforms that are currently in the preview/beta state.

- Virtual Memory (vMem) capacity utilized by the VM

In order for Turbonomic to retrieve vMem metrics, you must install and configure [Ops Agent](#) on each VM that it monitors.

- Virtual CPU (vCPU) capacity utilized by the VM

Turbonomic calculates capacity based on the normalized CPU frequency and the number of vCPUs for a given VM. Normalized CPU frequency takes into account performance variations seen in different models of a given CPU platform. Because frequency is normalized, charts might show utilization values that are slightly higher than 100% (for example, 100.03%) when capacity is fully utilized.

- Storage amount utilized by the VM
- IOPS and IO throughput (read/write) capacity utilized by the VM

Turbonomic calculates capacity or uses GCP-published capacity data, depending on the VM's machine type and disk.

- Shared-core machine types share a physical core and are used for running small, non-resource intensive apps.
 - For shared-core machine types with *standard disks*, Turbonomic uses capacity data that GCP publishes [here](#). Note that there are no published values for e2-micro and e2-small, so Turbonomic assumes the e2-medium capacity for these machine types.
 - For shared-core machine types with *SSDs*, Turbonomic calculates capacity based on the observed maximum limit that can be achieved for IOPS and IO throughput, and uses the calculated capacity to analyze utilization more accurately.

- For machine types that are *not* shared-core:
 - Turbonomic uses published capacity data and assumes that I/O block size is 16KB per I/O.
 - For machine types with persistent disks, Turbonomic assumes that the published capacity for the SSD disk type also applies to the *balanced* and *extreme* disk types. When a VM is attached to at least one of these disk types, capacity is assumed to be the per-VM limit for the SSD disk type. When a VM is attached only to the *standard* disk type, capacity is the per-VM limit for the standard disk type.
- Net throughput (inbound and outbound) for a VM

Actions

Use the Potential Savings and Necessary Investments charts to view pending actions and evaluate their impact on your cloud expenditure.

• Scale VM

Turbonomic can recommend scaling VMs to optimize performance and costs. To recommend accurate scaling actions, it analyzes resource utilization percentiles and workload costs, and checks scaling constraints defined in policies.

Points to consider:

- Since all GCP compute tiers have the same net throughput capacity, Turbonomic will not generate scaling actions in response to net throughput.
- For a VM with local SSDs, Turbonomic can recommend scaling to a machine type that supports local SSDs and the number of disks required by the VM, but cannot execute the action automatically due to prerequisite steps that you can only perform from GCP. You can view these prerequisites when you examine a pending action.
- Turbonomic does not recommend scaling actions for:
 - VMs running on sole-tenant nodes
 - VMs with attached GPUs
 - VMs in managed instance groups
 - VMs running custom machine types
- Analysis makes scaling recommendations based on committed use discounts (CUDs). Purchase recommendations for CUDs will be introduced in a future release.

Note:

For a list of committed use discounts that Turbonomic has discovered in your environment, see the Discount Inventory chart.

• Reconfigure VM

GCP provides a specific set of machine types for each zone in a region. If you create a policy that restricts a VM to certain machine types and the zone it is currently on does not support all of those machine types, Turbonomic will recommend a reconfigure action as a way to notify you of the non-compliant VM. For example, assume Zone A does not support machine types for the M1 family. When a VM in that zone applies a policy that restricts it to M1, Turbonomic will recommend that you reconfigure the VM.

GCP Plans

Plans that simulate GCP workload optimization or workload migration to GCP are currently in preview mode. We will include support for these plans in future releases.

Microsoft Azure

Microsoft Azure is Microsoft's infrastructure platform for the public cloud. You gain access to this infrastructure through a service principal target. To specify an Azure target, you provide the credentials for that account and Turbonomic discovers the resources available to you through that account.

Azure service principal targets will automatically discover the subscriptions to which the service principal has been granted access in the Azure portal. This in turn will create a derived target for each subscription that inherits the authorization provided by the service principal (e.g. contributor). Derived subscription targets are not directly modifiable but otherwise behave like any other target that may be validated and the inventory discovered.

Azure Government Targets

Add the service principal account for Azure Government to enable the discovery and management of your Azure Government workloads. When you add the account, be sure to enable the **US Government** toggle to indicate that the account you are adding is for Azure Government.

In order for Turbonomic to discover custom pricing and reserved instances for Azure Government, you must add the corresponding Enterprise Agreement (EA) accounts. For details about EA accounts, see [Microsoft Enterprise Agreement](#).

To use Azure Government with a firewall or proxy, it must be configured to allow unrestricted access to certain URLs. For details, see [Firewall and Proxy Access](#).

Support for Azure App Service

When you add an Azure account, Turbonomic discovers the app services and plans that make up your [App Service](#) deployment. In the supply chain, app services appear as Service entities, while plans that define the underlying compute resources for app services appear as Application Components.

To discover app services and plans, Turbonomic requires the same permissions for monitoring other Azure workloads.

Note:

App Service analysis and optimization will be introduced in a future release.

Supported Regions – Azure

Turbonomic supports discovery and management of entities in the following Azure regions:

Region Code	Region Name	Notes
eastus	East US	
eastus2	East US 2	
centralus	Central US	
northcentralus	North Central US	
southcentralus	South Central US	
westcentralus	West Central US	
westus	West US	
westus2	West US 2	
westus3	West US 3	
canadaeast	Canada East	
canadacentral	Canada Central	

Region Code	Region Name	Notes
brazilsouth	Brazil South	
brazilsoutheast	Brazil Southeast	
northeurope	North Europe	
westeurope	West Europe	
francecentral	France Central	
francesouth	France South	Access by request from Azure only (https://docs.microsoft.com/en-us/troubleshoot/azure/general/region-access-request-process)
ukwest	UK West	
uksouth	UK South	
germanynorth	Germany North	Access by request from Azure only (https://docs.microsoft.com/en-us/troubleshoot/azure/general/region-access-request-process)
germanywestcentral	Germany West Central	
norwayeast	Norway East	
norwaywest	Norway West	Access by request from Azure only (https://docs.microsoft.com/en-us/troubleshoot/azure/general/region-access-request-process)
switzerlandnorth	Switzerland North	
switzerlandwest	Switzerland West	Access by request from Azure only (https://docs.microsoft.com/en-us/troubleshoot/azure/general/region-access-request-process)
eastasia	East Asia	
southeastasia	Southeast Asia	
australiaeast	Australia East	
australiasoutheast	Australia Southeast	
australiacentral	Australia Central	
australiacentral2	Australia Central 2	Access by request from Azure only (https://docs.microsoft.com/en-us/troubleshoot/azure/general/region-access-request-process)
centralindia	Central India	
southindia	South India	
westindia	West India	
japaneast	Japan East	
japanwest	Japan West	
koreacentral	Korea Central	
koreasouth	Korea South	
uaacentral	UAE Central	Access by request from Azure only (https://docs.microsoft.com/en-us/troubleshoot/azure/general/region-access-request-process)

Region Code	Region Name	Notes
uaenorth	UAE North	
southafricanorth	South Africa North	
southafricawest	South Africa West	Access by request from Azure only (https://docs.microsoft.com/en-us/troubleshoot/azure/general/region-access-request-process)
usgovarizona	USGov Arizona	Restricted Access (GovCloud)
usgovtexas	USGov Texas	Restricted Access (GovCloud)
usgovvirginia	USGov Virginia	Restricted Access (GovCloud)
usdodcentral	USDoD Central	Restricted Access (GovCloud) - Untested
usdodeast	USDoD East	Restricted Access (GovCloud) - Untested

Prerequisites

- Azure Resource Manager

Note:

Turbonomic will not discover Azure Classic virtual machines, as they do not utilize the Azure Resource Manager.

You must allow at least 30 minutes of discovery time for Turbonomic to allow full discovery of the Resource Group information.

- External access via App Registration
- Subscription must be registered with the `Microsoft.Capacity` resource provider. This can be done in the settings section of the Azure portal.

Note:

When you first configure an Azure target, under some circumstances the target has No Quotas Available, and so Turbonomic cannot discover the available templates. This can happen when you initially set up the Azure account and you have not enabled any providers. If this occurs, you can install a single VM in your cloud subscription to make quotas available. Or you can navigate to the Azure Subscriptions Blade and select the subscription you want. Then for the resource providers, register the `Microsoft.Compute` option. For more information, see the following Microsoft article: [Resolve errors for resource provider registration](#).

Azure Service Principal and Subscription Permissions

For the Service Principal account, you must provide permissions to support all the actions you want to perform on any Subscription accounts.

Note:

If you use Azure Monitor Log Analytics to monitor VM resources:

Rather than enabling diagnostics on a per-VM basis, you may have created [Azure Monitor Log Analytics](#) workspaces to centralize the management of your Azure VM configurations. Turbonomic discovers these workspaces when you add Azure targets, and then retrieves performance metrics periodically.

If you have configured your Log Analytics workspace in a separate Azure subscription that is *not* configured as a Turbonomic target, then Turbonomic service accounts for Azure targets must have one of the following built-in roles in addition to other required permissions:

- Reader
- Log Analytics Reader

Generic Roles

You can use generic Azure roles to set up access for the account Turbonomic uses to access your target. This is an easy way to configure a target account, but you do not have full control over the access you grant to that account. For finer control, you should set the minimum permissions.

Permission Level	Required Roles
Read-Only (monitoring and recommendations)	Reader plus Storage Account Contributor The use of a combined Reader + Storage Account Contributor role is the minimum privileged combination required for Turbonomic to discover and access metrics across your Azure environment. The Storage Account Contributor role is required to access the Storage Account keys and establish a connection in order to retrieve VM memory statistics.
Execute Actions	Owner or Contributor To enable actions, you can use either the Owner or Contributor role. Contributor is the least privileged role which enables Turbonomic to execute actions in your Azure environment.

Minimum Permissions

To explicitly control the access that you grant to Turbonomic, as a minimum the account for an Azure target must have the following permissions:

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none">• Microsoft.Capacity/reservationOrders/*/read Monitor reservations pricing data.• Microsoft.Commerce/*/read Monitor pricing data.• Microsoft.Commerce/RateCard/read Discover pricing information from the Pay-as-you-go rate card.• Microsoft.Compute/*/read Monitor status of compute resources to inform VM scaling decisions.• Microsoft.Consumption/pricesheets/read Discover pricing information from an EA (Enterprise Agreement) Price Sheet.• Microsoft.ContainerService/managedClusters/read Discover managed clusters.• Microsoft.ContainerService/managedClusters/agentPools/read Discover agent pools on managed clusters.• Microsoft.Insights/*/read Monitor insights components.• Microsoft.Resources/subscriptions/read

Turbonomic Functionality	Required Permissions
	<p>The minimum for monitoring through a Service Principal target. The Azure-recommended Reader role and the */read permission include this permission.</p> <ul style="list-style-type: none"> • Microsoft.Network/networkInterfaces/read Discover utilization on the network interface. • Microsoft.Network/publicIPAddresses/read • Microsoft.Resources/subscriptions/*/read • Microsoft.Sql/managedInstances/*/read Discover managed instances. • Microsoft.Sql/servers/read Discover SQL Server instances. • Microsoft.Sql/servers/databases/*/read Discover metrics on SQL Server instances. • Microsoft.Storage/storageAccounts/listkeys/action Discover storage accounts as part of discovery for unmanaged disks.
<p>Execute VM Scaling, Start/Stop VM, Suspend VM</p>	<ul style="list-style-type: none"> • Microsoft.Compute/virtualMachines/write • Microsoft.Compute/virtualMachineScaleSets/write Enable actions per scale sets. • Microsoft.Network/networkInterfaces/join/action VM can rejoin network after scaling. • OPTIONAL: Microsoft.KeyVault/vaults/deploy/action For VM resize. Only needed if a VM is using Azure Key Vault, in order to deploy to the resized VM. • Microsoft.Compute/virtualMachines/deallocate/action Stop VM to execute disruptive action. • Microsoft.Compute/virtualMachineScaleSets/deallocate/action Stop VMs to execute disruptive action on scale set. • Microsoft.Compute/virtualMachines/start/action Restart VM after stopping to execute disruptive action. • Microsoft.Compute/virtualMachineScaleSets/start/action Restart VMs after stopping to execute disruptive action on scale set. • Microsoft.Compute/virtualMachines/powerOff/action Suspend a VM.
<p>Execute actions related to Microsoft Insights components</p>	<ul style="list-style-type: none"> • Microsoft.Insights/AutoscaleSettings/Write

Turbonomic Functionality	Required Permissions
Disk actions	<ul style="list-style-type: none"> • Microsoft.Compute/disks/write Resize or change storage tier of disks. Reconnect disk to virtual machine after resize. • Microsoft.Compute/disks/delete Delete unattached volume for managed disks. • Microsoft.Storage/storageAccounts/blobServices/containers/blobs/delete Delete unattached volume for managed disks.
SQL Database scaling	<ul style="list-style-type: none"> • Microsoft.Sql/servers/databases/write Scale databases per DTU or vCore pricing models. • Microsoft.Sql/servers/databases/pause/action Pause database. • Microsoft.Sql/servers/databases/resume/action Restart database.

For example, create a JSON file for your custom policy similar to the following, where **<Your_subscription_ID>** sets the role scope to the ID of the Azure subscription you want for this target:

```
{
  "Name": "Limited Access",
  "Description": "Limited access policy",
  "IsCustom": "true",
  "Actions": [
    "Microsoft.Capacity/reservationOrders/*/read",
    "Microsoft.Commerce/*/read",
    "Microsoft.Compute/*/read",
    "Microsoft.Compute/virtualMachines/start/action",
    "Microsoft.Compute/virtualMachines/deallocate/action",
    "Microsoft.Compute/virtualMachines/write",
    "Microsoft.Compute/virtualMachineScaleSets/write",
    "Microsoft.Compute/virtualMachineScaleSets/start/action",
    "Microsoft.Compute/virtualMachineScaleSets/deallocate/action",
    "Microsoft.Consumption/*/read",
    "Microsoft.ContainerService/managedClusters/agentPools/read",
    "Microsoft.ContainerService/managedClusters/read",
    "Microsoft.Insights/*/read",
    "Microsoft.Insights/AutoscaleSettings/Write",
    "Microsoft.Network/networkInterfaces/read",
    "Microsoft.Network/publicIPAddresses/read",
    "Microsoft.Resources/subscriptions/*/read",
    "Microsoft.Sql/managedInstances/*/read",
    "Microsoft.Sql/servers/databases/*/read",
    "Microsoft.Sql/servers/databases/pause/action",
    "Microsoft.Sql/servers/databases/resume/action",
    "Microsoft.Sql/servers/databases/write",
    "Microsoft.Sql/servers/read"
  ],
  "NotActions": [],
  "AssignableScopes": [
    "/subscriptions/<Your_subscription_ID>"
  ]
}
```

Creating Client Secret Key and Permission

To create the secret key:

1. Navigate to the Certificates and Secrets section of your registered app

2. Click on + New client secret

3. Create a new client secret. The description can be any valid name, and the expiration should be set to never

Note: Make sure to copy the secret. It **will not** be displayed again

External Access via App registration

The administrator of an Azure Active Directory (Tenant) can register an application with the tenant — This app registration gives an external application access to the tenant's resources. Turbonomic connects to an Azure target via an App registration.

To create an App registration in your tenant:

- Log into the Azure Management Portal
- Add an App registration to an available tenant — The tenant ID will correspond with the tenant ID that you set for the target.
- From the newly-created App registration blade in the Management Portal, go to the Overview blade
This blade displays the generated Directory (tenant) ID and Application (client) ID for this app.
- From the newly created App registration blade in the Management Portal, go to the Certificates and Secrets blade.

This blade displays previously created certificates and client secrets, as well as provides the ability to create them.

Note:

The administrator who creates the App registration must also create a Client secret key. This secret key must be recorded on creation. The administrator can return to the Management Portal to see the Application (client) ID, but the portal only shows the Client secret key once during creation.

For more information, refer to Microsoft's article, [How to: Use the portal to create an Azure AD application and service principal that can access resources](#).

Accessing the Subscriptions

1. Navigate to your Azure subscriptions list.
2. Select the first subscription you want Turbonomic to manage.
3. Navigate to the Access control for that subscription.
4. Add a role (see permissions prerequisite).
5. Add the application you registered with the tenant.

Note:

Repeat steps for each subscription that Turbonomic will manage.

Locked Storages and Resource Groups

In Azure environments, a subscription can use locked storage or locked resource groups. For such subscriptions, Turbonomic discovers incomplete data. Locked resources affect Turbonomic discovery in either of these scenarios:

- Locked resource group

Turbonomic discovers all the entities in the resource group, but does not discover the resource group itself. For example, in the Top Accounts chart, the Resource Groups field will show no resource groups for a subscription that has a locked resource group.

- Locked storage

Turbonomic discovers all the entities in the resource group except the locked storage. It also discovers the resource group.

Accessing Reservations (RIs)

To manage the use of Azure Reservations (also referred to as *Reserved Instances* or *RIs* in the Turbonomic documentation), the App registration (Service Principal or SPN) for this target must have permissions to manage the RIs. In most cases, Reader permissions are sufficient.

For scoped RIs, Turbonomic supports the *subscription* and *shared* scopes. To discover these RIs, you must assign the Azure App registration Reader permissions to both the Reservation and the Reservation Order (order id) of all the RIs. For details about reservation orders, see the Microsoft article, [Manage Reservations for Azure resources](#).

Turbonomic also discovers RIs scoped to a *resource group*, but treats them as shared (in the RI Inventory chart, the scope for these RIs is shown as Shared*). This could result in unreliable actions, such as scaling VMs within the resource group to other RIs, which could potentially increase costs. If you have existing RIs scoped to a resource group, be sure to change their scope in Azure before executing VM scale actions. For best results, change their scope to *shared*.

Adding Azure Targets

To add Azure targets, select **Cloud Management > Azure** on the Target Configuration page, and provide the following information:

- Display Name

The display name that will be used to identify the target in the Target List. This is for display in the UI only; it does not need to match any internal name.

- US Government

Turn this on to configure the target as an Azure Government target.

- Directory (Tenant) ID

The ID of the tenant that contains subscriptions to be managed with Turbonomic.

- Application (Client) ID

The Client/App ID of the App Registration that gives Turbonomic access to resources in your Azure subscription.

- Client Secret Key

The secret key for the App Registration.

Firewall and Proxy Access

If you run Turbonomic behind a proxy or firewall, then you must configure Turbonomic to allow unrestricted access to the following URLs. This enables the full set of features for Azure Service Principal targets.

For Azure (Global):

- `ratecard.azure-api.net`
- `management.core.windows.net`
- `management.azure.com`
- `login.microsoftonline.com`
- `ratecard.blob.core.windows.net`
- `api.loganalytics.io`

For Azure Government:

- `ratecard.azure-api.net`

- `management.core.usgovcloudapi.net`
- `management.usgovcloudapi.net`
- `login.microsoftonline.us`
- `ratecard.blob.core.usgovcloudapi.net`
- `api.loganalytics.us`

Cloud Instance Family Support

You can see the cloud instance families that Turbonomic manages in the User Interface:

- Navigate to **Settings > Policies > Virtual Machines Defaults**
- In that policy, add **Scaling Constraint** and choose **Cloud Instance Types**
- Click **Edit**

The policy page shows lists of supported Cloud instance types for each clout provider.

Enabling Collection of Memory Statistics

We highly recommend enabling collection of memory metrics in your Azure environment. With memory metrics, Turbonomic can generate actions that not only boost performance but also maximize your savings.

For Turbonomic to collect memory statistics in Azure, you must enable the collection of these statistics on the VMs in your environment. You can do this as you deploy your VMs, or you can enable the counters on VMs you have already deployed. For more information, see [Enabling Collection of Memory Statistics: Azure](#).

Actions

Turbonomic recommends actions for the cloud target supply chain as follows.

Virtual Machines (Cloud)

- Scale up to template (based on VMem / VCPU)
- Scale down to template (based on VMem / VCPU)
- Move Virtual Machine (intra-cloud)

Note:

This is a destructive move- data / applications are not preserved. This action also requires both a Turbonomic merge policy and the moved VM to be a Linux VM with template configuration.

Monitored Resources

Turbonomic monitors the following resources for the cloud target supply chain:

Virtual Machine (Azure)

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)
- Storage Amount
The utilization of the datastore's capacity

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The utilization of IOPS allocated for the VStorage on the VM

Measured in IOPS

- I/O Throughput

The throughput to the underlying storage for the entity

Measured in KB/s

- Latency

The utilization of latency allocated for the VStorage on the VM

Measured in milliseconds (ms)

Database Server

- Virtual CPU (VCPU)

The utilization of the VCPU allocated to the hosting VM

Measured in Megahertz (MHz)

Database

Note:

The resources that Turbonomic can monitor depend on the pricing model in place for the given database entity.

- DTU Pricing Model

- DTU

DTU capacity for the database. DTU represents CPU, memory, and IOPS/IO Throughput bundled as a single commodity.

- Storage

Storage capacity for the database.

- vCore Pricing Model

- Virtual Memory (VMem)

The utilization of VMem allocated to the Database instance

- Virtual CPU (VCPU)

The utilization of VCPU allocated to the Database instance

- Storage Access (IOPS)

The rate of input and output operations per second utilized by the Database instance

- Throughput

The throughput utilization of transaction log write IO available to the Database instance

- Storage

Storage capacity for the database.

Turbonomic drives scaling actions based on the utilization of these resources, and treats the following limits as constraints when it makes scaling decisions:

- Maximum concurrent sessions

Maximum number of database connections at a time.

- Maximum concurrent workers

Maximum number of database processes that can handle queries at a time.

Volume

- Storage Access

The percentage of the volume's capacity for storage access operations (measured in IOPS) that is in use.

- IO Throughput

The percentage of the volume's capacity for IO throughput (measured in MB/s) that is in use.

- IO Throughput Read

The percentage of the volume's capacity for IO throughput Read (measured in MB/s) that is in use.

- IO Throughput Write

The percentage of the volume's capacity for IO throughput Write (measured in MB/s) that is in use.

Microsoft Enterprise Agreement

You can configure Turbonomic to manage Azure subscriptions within the context of an Enterprise Agreement (EA). An EA target enables Turbonomic to use custom pricing and discover reserved instances. When you configure an EA target, Turbonomic uses that richer pricing information to calculate workload size and RI coverage for your Azure environment.

To enable Turbonomic management of Azure EA environments, you must configure both an EA target and at least one service principal target. For more information about service principal targets, see [Adding Azure Targets](#).

Prerequisites

- Microsoft Azure EA access key
- Your Microsoft Azure EA enrollment number
- Enable access to your Azure Billing Data

You can enable access to costs in the Azure portal or in the EA portal. For complete information, see [Assign access to Cost Management data](#) in the Microsoft documentation.

Azure Portal:

1. Log into to the Azure portal (<https://portal.azure.com>).

You should log in with an enterprise administrator account.

2. Open your Billing Account.

Navigate to **Cost Management + Billing | Billing scopes**. Select your billing account from the list of available accounts.

3. Configure cost access.

In the **Settings** group, select **Policies**. Then turn on **DEPARTMENT ADMINS CAN VIEW CHARGES** and **ACCOUNT OWNERS CAN VIEW CHARGES**.

EA Portal:

1. Log into to the Azure portal (<https://ea.azure.com>).

You should log in with an enterprise administrator account.

2. Select **Manage** in the left-hand navigation pane
3. Configure cost access.

For the cost management scopes that you want to provide access to, enable the charge option to **DA view charges** and/or **AO view charges**.

Note:

After you configure cost access, most scopes also require Azure role-based access control (Azure RBAC) permission configuration in the Azure portal.

If you just enabled these settings, it can take up to 24 hours for the changes to take effect. For more information, see [Troubleshoot enterprise cost views in the Microsoft Azure documentation](#).

If you perform self-service exchanges for your RIs, Turbonomic does not discover the new charges for the exchanged RIs through the Azure EA target. To track the charges after you have exchanged RIs, ensure you have an Azure subscription target for the affected scope of Azure workloads, and that subscription has read access to reserved instances information.

- Your firewall must allow access to the `consumption.azure.com:443` address.

Adding Microsoft Enterprise Agreement Targets

To add a Microsoft Enterprise Agreement target, select the **Cloud Management > Microsoft Enterprise Agreement** option on the Target Configuration page and provide the following information:

- Target Name

A user-friendly name that will identify the target

- Enrollment Number

The Enterprise Agreement enrollment number (found in your EA admin account at ea.azure.com)

- API Key

The API Access Key for the Enterprise Agreement (found in your EA admin account at ea.azure.com)

- Proxy Host

The IP address of the proxy server used, if any

- Proxy Port

The port number of the proxy server

- Proxy User

The username of the proxy user used to authenticate

- Proxy Password

The password of the proxy user used to authenticate

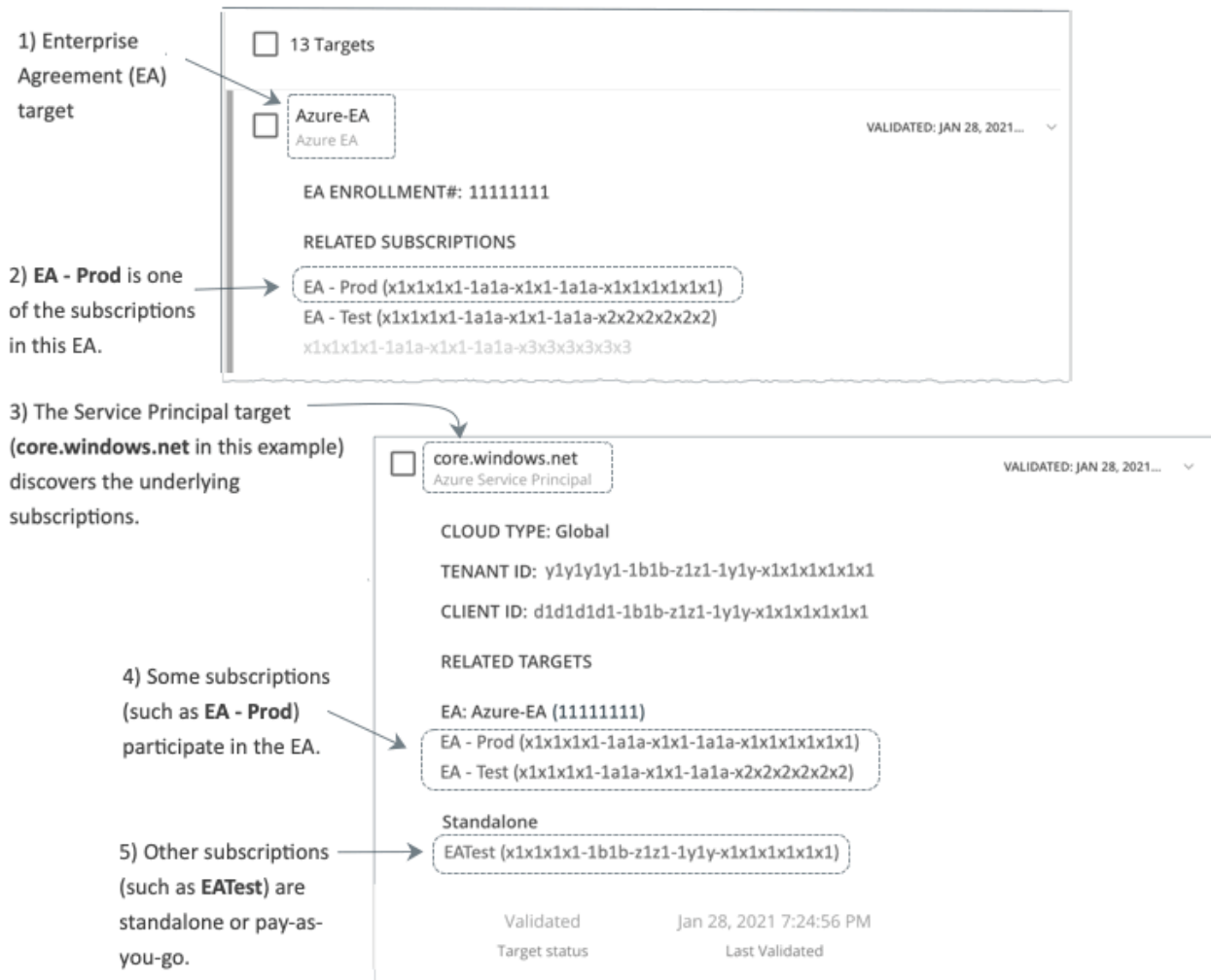
When you add the target and it validates, Turbonomic:

- Recognizes any existing Azure targets in your environment that are part of the EA
- Updates these targets with custom prices from the EA
- Discovers RIs in these targets

Note that this can take up to 24 hours, as target stitching occurs after the next bill processing cycle.

Note: Turbonomic does not generate actions on the EA target specifically, but for the underlying service principal targets. For information about actions and monitored resources for Azure targets, see [Adding Azure Targets](#).

Azure Enterprise Agreements



You can configure Turbonomic to manage Azure subscriptions within the context of an Enterprise Agreement (EA). An EA defines specific pricing, including the pricing for Reserved Instances (RIs). When you configure an EA target, and set the EA key to your Azure targets, Turbonomic uses that richer pricing information to calculate workload placement and RI coverage for your Azure environment.

To enable Turbonomic management of Azure EA environments, you must configure:

- One Microsoft Enterprise Agreement target
- At least one Service Principal target that can discover the underlying Azure subscriptions

For information about Azure targets, see [Microsoft Azure](#).

In the Targets View, you can identify the targets related to Azure EA as follows:

- EA Targets

The target that discovers the EA to track pricing and RI information. You can have one EA target per Turbonomic deployment.

- Azure Subscription Targets

The targets that manage the workloads in your Azure environment. These are discovered by Service Principal targets. Note that not all subscription targets *necessarily* participate in the EA. Expand these entries to see the related Service Principal target. For members of the EA, you can see the related EA target as well.

Subscriptions that do not participate in the EA appear as Standalone targets.

Note:

In rare circumstances, you can have a subscription that is not in use – The subscription has no workloads associated with it. In this case, Turbonomic identifies the subscription as Standalone. This is because the target cannot discover any cost or usage information that would relate the subscription to its EA.

- Service Principal Targets

The Azure target that you configure to discover Azure subscription targets. Expand the entry to see the discovered targets. If you have configured an EA target, the entry lists that as well, along with the EA enrollment number.

Reserved Instances and Azure EA

For Azure environments, Turbonomic can only discover and use RIs if you have configured a Microsoft Enterprise Account target, and if one or more subscriptions participate in that EA.

To discover and manage RIs in Azure environments, Turbonomic uses both the EA target and the associated subscription targets. On its own, a subscription target exposes costs for pay-as-you-go pricing. The EA target discovers pricing for the available RI instance types. Turbonomic combines this information to track:

- RI utilization
- RI coverage
- Virtual machine costs (accounting for RIs)

Note:

This release of Turbonomic does not support RI discovery and management for Classic VMs and Classic Cloud Services. Also, it does not support RI discovery and management for Suppressed Core virtual machines.

Cost Calculations for Azure Environments

To understand the reported costs in your Azure environment, consider these points:

- For targets that participate in the EA, Turbonomic uses the terms of the given EA, and bases costs on the Offer ID that is effective for the given subscription.
- For VMs in Azure, RI pricing does not include the cost of the OS license. However pricing for on-demand VMs does include the license cost.

Note:

For Microsoft Azure EA environments, the projected cost for RI Purchase actions might not match associated costs you find in the Microsoft Pricing Calculator.

Turbonomic actions can recommend RI purchases. For these recommendations, the action assumes a free Linux OS, so the cost estimate does not include the OS cost. However, The Microsoft Pricing Calculator does include costs for OS licenses. As a result, when you compare the Turbonomic cost estimates to the values in the Pricing Calculator, it's likely that the two estimates will not match. This difference also affects the Break Even Point that appears in the Recommended RI Purchases chart. Because the recommended purchases do not include Azure costs for OS licenses, the listed Break Even Point can be optimistic.

- For workloads you migrated from on-prem to the Azure cloud, Turbonomic recognizes Azure Hybrid Benefit (AHUB) savings for RIs and on-demand workloads. The costs you see in Turbonomic charts include this benefit. However, remember that recommended actions do not include any license cost, so the actions will not reflect any proposed AHUB savings (see above).

Storage Targets

Adding a storage Target enables Turbonomic to connect to your storage subsystem through a native or SMI-S provider API. Turbonomic uses the target's API to access and collect information from each of the underlying disk arrays. The information is used to set disk performance characteristics according to the type and capacity of storage, leading to improved workload placement.

Similarly, Turbonomic determines the relationships between storage controllers and disk arrays, and the location of datastores within those arrays. This information also helps optimize workload placement at a more granular level.

For on-premises applications, this optimization will enable Turbonomic to make more informed decisions about which storage devices the workloads hosting your applications run on, and assist in assuring application SLO. In the cloud, storage data is handled as part of the public cloud target.

Both virtual machines and containers benefit from this level of optimization. In the case of short-lived containers, Turbonomic will suggest the best datastore to hold persistent data, and paired with a container or hypervisor target, will select the optimal match of compute and storage resources. For longer-lived containers and virtual machines, each workload will be continually assessed for SLA/SLO, and recommendations to move or resize storages will ensure the continued efficiency of your environment.

The section below describes the storage supply chain. For information on how to add specific storage targets, the resources Turbonomic can monitor for the various supply chain entities, and the actions it can take to optimize the environment, refer to the target configuration instructions for your specific storage type.

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities in turn host Storage entities (datastores).

Entity Mapping

Turbonomic Mapping	EMC VMAX	HPE 3Par	NetApp	Pure
Storage	Volume (Regular, Thin, Meta)	Virtual Volume	Volume	Volume
Disk Array	Disk Group or Thin Pool	CPG	Aggregate	Shelf Array
Storage Controller	VMAX Array	Controller	Controller / Filer	Controller

Actions

Turbonomic recommends actions for storage targets as follows.

Note:

This is a general list of actions for storage managed by storage controllers. Specific actions Turbonomic can recommend, and which actions it can automate depends on the actual technology — Not all actions make sense for all types of storage. For example, Turbonomic can automate a datastore move across disk arrays or storage controllers for NetApp in C mode, but not for other storage technologies.

You can see how actions differ per technology in each section that describes adding a specific type of Storage Manager target.

Storage

- Start Storage

- Provision Storage
- Suspend Storage
- Move (only with Storage Targets configured)
- Resize (only with Storage Targets configured)

Disk Arrays

- Provision Disk Array
- Start Disk Array
- Suspend Disk Array
- Move Disk Array (for NetApp Cluster-Mode, only)
- Move Virtual Machine
- Move Datastore

Storage Controller

- Provision Storage Controller (recommendation only)

Monitored Resources

Turbonomic monitors the following storage resources:

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Disk Array

- Storage Amount
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the Disk Array's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the disk array

Measured in Operations per second

- Latency

The utilization of latency, computed from the latency of each device in the disk array.

Measured in milliseconds (ms)

Storage Controller

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- CPU

The utilization of the Storage Controller's allocated CPU

Measured in Megahertz (MHz)

- Storage Amount

The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.

Measured in Megabytes (MB)

EMC VMAX

Turbonomic supports management of VMAX2 and 3 Series storage arrays. The VMAX series is a family of enterprise storage arrays designed for SAN environments. Turbonomic connects to VMAX storage systems via an EMC SMI-S provider that has the disk arrays added to it. A single SMI-S provider can communicate with one or more disk arrays. When you specify an SMI-S provider as a target, Turbonomic discovers all the added disk arrays.

Note:

Turbonomic does not utilize Unisphere. Data is collected exclusively from the SMI-S provider.

Turbonomic will create Storage Groups based on the SLO levels defined in VMAX3 Targets. By default, Storage vMotion actions will respect these SLO levels based on the configured response time.

Prerequisites

- EMC SMI-S Provider V8.x
- A service account that Turbonomic can use to connect to the EMC SMI-S Provider (typically the default admin account)

Adding VMAX Targets

To add VMAX targets, select the **Storage > VMAX** option on the Target Configuration page and provide the following information:

- Address

The IP or host name of the SMI-S provider. If the provider address begins with https, you must follow the IP with the port used to connect.

- Use Secure Connection

If checked, port 5989 will be used to connect. If unchecked, port 5988 will be used.

- Username

The Username for the SMI-S provider.

- Password

The Password for the SMI-S provider.

Entity Comparison

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in EMC VMAX to those used in Turbonomic:

EMC VMAX Name	Turbonomic Entity
Volume (Regular, Thin, Meta)	Storage
Storage Resource Pool (VMAX3) / Thick Provisioned Pool (earlier)	Disk Array
Storage Group (VMAX3) / Thin Provisioned Pool (earlier)	Logical Pool
VMAX Array	Storage Controller

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
Storage	Provision (Cloning), Delete, Move	Resize (V-Volumes only)
Logical Pool		Resize

Monitored Resources

When calculating available storage, Turbonomic excludes disks devoted to the VMAX operating system by default. If these disks are assigned to new raid groups or storage pools, the capacity of those disks will then be considered when calculating the capacity of the Storage Controller.

Turbonomic monitors the following storage resources:

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency

The utilization of latency on the datastore

Measured in Milliseconds (ms)

Logical Pool

- Storage Amount
The utilization of the logical pool's capacity.
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the logical pool's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the logical pool.
Measured in Operations per second
- Latency
The utilization of latency on the logical pool.
Measured in milliseconds (ms)

Disk Array

- Storage Amount
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the Disk Array's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the disk array
Measured in Operations per second
- Latency
The utilization of latency, computed from the latency of each device in the disk array.
Measured in milliseconds (ms)

Storage Controller

- Storage Amount
The utilization of the storage controller's capacity.
Measured in Megabytes (MB)

EMC XtremIO

EMC® XtremIO® is a flash-based (SSD) storage solution, designed to push data to applications at higher speeds. The system building blocks are SAN appliances called X-Bricks. A deployment is organized into clusters of X-Bricks, and the clusters are managed by the XtremIO Management Server (XMS).

Turbonomic connects to X-Bricks through the XMS. The XMS presents a unified view of each connected X-Brick cluster, rather than exposing the individual X-Bricks within each cluster. Within Turbonomic, each X-Brick cluster displays as a single storage controller with an associated disk array.

The relationship between Storage entities and individual X-Bricks within the cluster is not exposed through the XMS — Turbonomic cannot make recommendations to move datastores from one X-Brick to another. Additionally, the X-Brick has a fixed form factor — Turbonomic does not recommend resize actions for disk array or storage controller resources.

Turbonomic recognizes XtremIO arrays as flash storage and sets the IOPS capacity on discovered arrays accordingly.

Prerequisites

- A service user account on XMS 4.0 or higher — typically the default `xmsadmin` account

Turbonomic uses this account to connect to the XMS and execute commands through the XtremIO API.

Adding XtremIO Targets

For EMC XtremIO targets, select the **Storage > EMC XtremIO** option on the Target Configuration page and provide the following information:

- Address

The name or IP address of the XtremIO Management Server (XMS).

- Username/Password

Credentials for a user account on the XMS.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in XtremIO to those used in Turbonomic:

XtremIO Name	Turbonomic Entity
Volume	Storage
XtremIO Cluster	Disk Array
XtremIO Cluster	Storage Controller

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory [Storage Supply Chain](#).

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
Storage		Provision, Resize Up
Disk Array		
Storage Controller		Provision

Monitored Resources

When calculating available storage, Turbonomic excludes disks devoted to the VNX operating system.

Turbonomic monitors the following storage resources:

Storage

- **Storage Amount**
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- **Storage Provisioned**
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- **Storage Access Operations Per Second (IOPS)**
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- **Latency**
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Disk Array

- **Storage Amount**
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- **Storage Provisioned**
The utilization of the Disk Array's capacity, including overprovisioning.
Measured in Megabytes (MB)
- **Storage Access Operations Per Second (IOPS)**
The summation of the read and write access operations per second on the disk array
Measured in Operations per second
- **Latency**
The utilization of latency, computed from the latency of each device in the disk array.
Measured in milliseconds (ms)

Storage Controller

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- **CPU**
The utilization of the Storage Controller's allocated CPU
Measured in Megahertz (MHz)
- **Storage Amount**
The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.

Measured in Megabytes (MB)

EMC ScaleIO

EMC ScaleIO is an example of Software-Defined Storage for the datacenter. It creates a Virtual SAN overlaying commodity infrastructure that consists of multiple LAN-connected Servers with locally attached commodity Storage. It presents a standard Block Storage interface to Applications accessing the Virtual SAN.

Turbonomic communicates with the EMC ScaleIO system via the REST API Gateway.

Prerequisites

- EMC ScaleIO 2.x or 3.x
- A service account that Turbonomic can use to connect to the ScaleIO Gateway.

Adding EMC ScaleIO Targets

To add EMC ScaleIO targets, select the **Storage > EMC ScaleIO** option on the Target Configuration page and provide the following information:

- Address
The IP or host name of the Gateway.
- Username
The Username for the Gateway service account.
- Password
The Password for the Gateway service account.

Entity Comparison

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in EMC ScaleIO to those used in Turbonomic:

EMC ScaleIO Name	Turbonomic Entity
Volume	Storage
Storage Pool	Disk Array
Protection Domain	Storage Controller

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
Storage	Provision (Cloning)	Resize (Disabled by default)
Disk Array		Resize Disk Array
Protection Domain		Provision (Cloning)

Monitored Resources

Turbonomic monitors the following storage resources:

Storage

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- **Storage Amount**
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- **Storage Provisioned**
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- **Storage Access Operations Per Second (IOPS)**
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Disk Array

- **Storage Amount**
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- **Storage Provisioned**
The utilization of the Disk Array's capacity, including overprovisioning.
Measured in Megabytes (MB)
- **Storage Access Operations Per Second (IOPS)**
The summation of the read and write access operations per second on the disk array
Measured in Operations per second
- **Latency**
The utilization of latency, computed from the latency of each device in the disk array.
Measured in milliseconds (ms)

Storage Controller

- **Storage Amount**
The utilization of the storage controller's capacity.
Measured in Megabytes (MB)

EMC VPLEX

Turbonomic supports management of EMC VPLEX virtual storage systems in a local configuration, via the VPLEX API. Currently, Turbonomic does not support Metro or Geo configurations.

VPLEX is used to aggregate and refine data collected between connected Storage and Hypervisor targets. VPLEX supports one-to-one, one-to-many, and many-to-one relationships between virtual volumes and LUNs. Only one-to-one mapping between virtual volume and LUNs is supported by Turbonomic.

Prerequisites

- VPLEX Management Server
- Hypervisor target supported by Turbonomic
- Storage target supported by Turbonomic

Note:

In order for Turbonomic to make use of the information provided by VPLEX, you must also add the hypervisor and storage layered under it as targets.

VPLEX Permissions

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none">• Service Account
Action Execution	<ul style="list-style-type: none">• Admin account

Adding EMC VPLEX Targets

To add EMC VPLEX targets, select the **Storage > EMC VPLEX** option on the Target Configuration page and provide the following information:

- Address:
The IP or Hostname of the VPLEX Management Server
- Username:
The Username for the VPLEX Management Server
- Password:
The Password for the VPLEX Management Server
- Port Number:
The port number for the remote management connection. The default port number for the VPLEX Management server is 443
- Secure Connection:
Select this option to use a secure connection (HTTPS)

Note:

The default port (443) uses a secure connection.

Supported Actions

For this target, actions are generated and executed via the underlying storage targets. Turbonomic will use the enhanced visibility provided by VPLEX to make more intelligent storage decisions- for example, recommending storage vMotion between pools.

HPE 3PAR

HPE 3PAR StoreServ systems use controller nodes to manage pools of storage resources and present a single storage system to consumers. Turbonomic communicates with the HPE 3PAR system via both the WSAPI and SMI-S providers that are installed on the 3PAR controller node.

Prerequisites

- SMI-S Provider enabled and configured on the controller node.

- WSPAI Provider enabled and configured on the controller node.
- A service account on the controller node that Turbonomic can use to connect to the SMI-S and WSPAI providers.

Note:

For discovery and monitoring, the Turbonomic service account must have the Browse permission on all monitored domains. To exclude domains from monitoring, the Turbonomic service account must have no permissions on those domains. For action execution, Turbonomic requires the Edit permission.

Setting Up the SMI-S Provider

The HPE 3PAR SMI-S Provider should be installed on the controller node. It is disabled by default — you must ensure that it is installed properly and running on the controller node.

To enable the SMI-S provider:

1. Log into the HPE 3PAR Command Line Interface (CLI).

Open a secure shell session (ssh) on the controller node. Default credentials are 3paradm/3pardata.

2. Check the current status of the SMI-S provider.

In the shell session, execute the command, `showcim`.

3. If the CIM service is not running, start it.

Execute the command `startcim` to enable the CIM service and the SMI-S provider.

To stop the SMI-S provider, execute the command `stopcim -f -x`.

Setting Up the WSAPI Provider

The HPE 3PAR WSAPI Provider should be installed on the controller node.

To enable the WSAPI provider:

1. Log into the HPE 3PAR Command Line Interface (CLI).

Open a secure shell session (ssh) on the controller node. Default credentials are 3paradm/3pardata.

2. Check the current status of the WSAPI provider.

In the shell session, execute the command, `showwsapi`.

3. If the WSAPI service is not running, start it by executing the command `startwsapi`.

Execute the command `set wsapi -http enable` to allow only insecure connections, or `set wsapi -https enable` to allow only secure connections.

To stop the WSAPI provider, execute the command `stopwsapi -f`.

Adding HPE 3PAR Targets

To add an HPE 3PAR target, select the **Storage > HPE 3Par** option on the Target Configuration page and provide the following information:

- Address

The name or IP address of the 3PAR controller node.

By default, the controller provides SMI-S data over port 5988 (HTTP) or port 5989 (HTTPS). If your installation uses a different port for SMI-S, include the port number in the Address field.

- Username/Password

Credentials for a user account on the controller node.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in HPE 3PAR to those used in Turbonomic:

HPE 3PAR Name	Turbonomic Entity
Virtual Volume	Storage
CPG	Disk Array
AO Configuration	Logical Pool
Controller	Storage Controller

Supply Chain

Storage targets (storage controllers) add Storage Controller, Logical Pool and Disk Array entities to the supply chain. Logical Pool and Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory [Storage Supply Chain](#).

3Par Adaptive Optimization

Adaptive Optimization (AO) for HPE 3Par enables management of data storage across two or three tiers. AO places storage regions on the appropriate tier in response to periodic analysis that AO performs.

To work with the storage in an AO group, Turbonomic:

- Discovers each Common Provisioning Group (CPG) as a disk array

In the Turbonomic user interface, these disk arrays do not host storage — They appear empty.

Turbonomic will not recommend storage moves between these disk arrays, because such moves would conflict with AO block-level placement.

- Creates a single logical pool that hosts all the datastores in an AO group

This logical pool represents the AO group, and it includes all the member CPGs. Turbonomic considers this single logical pool when it performs analysis — It can recommend moving storage into or out of the AO group. Also, Turbonomic aggregates resource capacity in this logical pool. For example, the IOPS capacity for the AO logical pool is a combination of IOPS capacity for the constituent CPGs.

You can see the AO logical pool in the Turbonomic user interface. The display name for this logical pool is the name of the AO Configuration.

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
Storage	Provision, Resize Up/Down	
Disk Array	Provision, Resize Up/Down	
Logical Pool		Provision, Resize Up/Down
Storage Controller		Provision

Monitored Resources

Turbonomic monitors the following storage resources:

Storage

- Storage Amount

The utilization of the datastore's capacity

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the datastore's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the datastore

Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency

The utilization of latency on the datastore

Measured in Milliseconds (ms)

Disk Array

- Storage Amount

The utilization of the Disk Array's capacity.

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the Disk Array's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the disk array

Measured in Operations per second

- Latency

The utilization of latency, computed from the latency of each device in the disk array.

Measured in milliseconds (ms)

Logical Pool

- Storage Amount

The utilization of the logical pool's capacity.

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the logical pool's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the logical pool.

Measured in Operations per second

- Latency

The utilization of latency on the logical pool.

Measured in milliseconds (ms)

Storage Controller

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- CPU

The utilization of the Storage Controller's allocated CPU

Measured in Megahertz (MHz)

- Storage Amount

The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.

Measured in Megabytes (MB)

IBM FlashSystem

IBM® FlashSystem family comprises all-Flash storage-array platforms. The platform delivers an active-active dual controller system. Assuming a pair of controller nodes, the active-active controller pair can process I/O for a specific volume through either node.

A FlashSystem control enclosure contains multiple NVMe-attached IBM FlashCore® Modules or other self-encryption NVMe-attached SSD drives. Each control enclosure contains two identical node canisters. A node canister provides host interfaces, management interfaces, and interfaces to the control enclosure. The pair of nodes within a single enclosure is known as an input/output (I/O) group.

Note:

For deployments that include mirrored volumes, Turbonomic discovers the Primary copy, and uses data from that for analysis and to generate actions. It does not discover the Secondary copy.

Prerequisites

- A service user account on the FlashSystem controller

You must configure a user account on the FlashSystem with a `Monitor` role. This user account must be dedicated to a single Turbonomic instance. To manage one FlashSystem with multiple Turbonomic instances, you must create a different user account for each Turbonomic instance.

- Spectrum Virtualize REST version 8.3.1.2 or later (8.4.2.0 or later recommended)

To take advantage of significant improvements to the Spectrum Virtualize interface, we recommend that you use Spectrum Virtualize version 8.4.2.0 or later.

IBM FlashSystem Permissions

Turbonomic Functionality	Required Permissions
Monitoring	<ul style="list-style-type: none">• Service Account with a <code>Monitor</code> role

Considerations

When you configure a FlashSystems target, you should consider:

- FlashSystem devices under IBM SVC management are not currently supported.
- Turbonomic does not discover mirrored volumes or child pools.
- Clusters must consist of a single enclosure.

Adding IBM FlashSystem Targets

For FlashSystem targets, select the **Storage > IBM FlashSystem** option on the Target Configuration page. Then provide the following:

- Address

The host name or Management IP address of the FlashSystem Cluster.

- Username

The username for a dedicated Turbonomic user account on the FlashSystem instance.

- Password

The password for the given user account.

Supply Chain

IBM FlashSystem Cluster targets add Storage Controller, Disk Array, and Logical Pool entities to the supply chain. Logical Pool entities provide Storage entities, which the supply chain stitches to Hypervisor storage (for example, vCenter datastores).

The FlashSystem components that Turbonomic discovers map to supply chain entities as follows:

FlashSystem Name	Supply Chain Entity	Description
Volume (VDisk)	Storage	A logical disk that the system presents to attached hosts. You create Volumes from the extents that are available in the pool.
Pool (MDiskGroup)	Logical Pool	An allocated amount of capacity that jointly contains all of the data for a specified set of volumes. All MDisks in a pool are split into extents of the same size.
MDisk (Array)	Disk Array	A logical unit of physical storage. MDisks are not visible to host systems.
System (Enclosure or Controller)	Storage Controller	A FlashSystem control enclosure.

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity	Actions
Storage Controller	<ul style="list-style-type: none">• Disabled by default<ul style="list-style-type: none">– Provision
Disk Array	<ul style="list-style-type: none">• Disabled by default<ul style="list-style-type: none">– Resize– Move– Provision– Start– Suspend

Entity	Actions
Logical Pool	<ul style="list-style-type: none"> • Recommend by default <ul style="list-style-type: none"> – Resize (add or remove MDisk) • Disabled by default <ul style="list-style-type: none"> – Move – Provision – Start – Suspend
Storage	<ul style="list-style-type: none"> • Manual by default <ul style="list-style-type: none"> – Delete • Recommend by default <ul style="list-style-type: none"> – Resize – Move – Provision – Start • Disabled by default <ul style="list-style-type: none"> – Suspend
Virtual Machine	<ul style="list-style-type: none"> • Recommend by default <ul style="list-style-type: none"> – Storage vMotion

Monitored Resources

To discover and monitor resources, Turbonomic uses the Spectrum Virtualize REST interface, and it securely retrieves `iostats` files from the configuration node.

Turbonomic monitors the following storage resources:

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency
The utilization of latency on the datastore

Measured in Milliseconds (ms)

Logical Pool

- Storage Amount
The utilization of the logical pool's capacity.
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the logical pool's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the logical pool.
Measured in Operations per second
- Latency
The utilization of latency on the logical pool.
Measured in milliseconds (ms)

Disk Array

- Storage Amount
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the Disk Array's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the disk array
Measured in Operations per second
- Latency
The utilization of latency, computed from the latency of each device in the disk array.
Measured in milliseconds (ms)

Storage Controller

- CPU
The utilization of the Storage Controller's allocated CPU
Measured in Megahertz (MHz)
- Storage Amount
The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.
Measured in Megabytes (MB)

NetApp

The Storage Control Module adds support for NetApp filers running the Data ONTAP operating system. NetApp storage controllers are Storage Virtual Machines that manage storage arrays. Turbonomic connects to these storage controllers to support NetApp targets in Cluster-Mode (C-Mode).

Prerequisites

- Transport Layer Security (TLS) is enabled
- A service account Turbonomic can use to connect to the NetApp target

Enabling TLS

Starting with version 5.4, by default Turbonomic requires Transport Layer Security (TLS) version 1.2 to establish secure communications with targets. NetApp filers have TLS disabled by default, and the latest version they support is TLSv1. If your NetApp target fails to validate on Turbonomic 5.4 or later, this is probably the cause.

If target validation fails because of TLS support, you might see validation errors with the following strings:

- No appropriate protocol

To correct this error, ensure that you have enabled the latest version of TLS that your target technology supports. If this does not resolve the issue, please contact IBM Technical Support.

- Certificates does not conform to algorithm constraints

To correct this error, refer to your NetApp documentation for instructions to generate a certification key with a length of 2048 or greater on your target server. If this does not resolve the issue, please contact IBM Technical Support.

For information about enabling TLS, see the Data ONTAP **System Administration Guide** for sections on the SSL protocol.

Service User Account — Administrator Role

To discover and fully manage NetApp disk arrays, Turbonomic must have a service account that grants privileges to execute commands through the NetApp filer's OnTap API (ontapi). In most cases, you can create the administrator account via the NetApp OnCommand System Manager, or from the NetApp command line — For example:

```
security login create -role admin -username IBM -application ontapi -authmethod password.
```

If you prefer not to grant full administrator rights, see [Creating Restricted Service Accounts In NetApp](#)

Adding NetApp Targets

To add a NetApp target, select the **Storage > NetApp** option on the Target Configuration page and provide the following information:

- Address

The name or IP address of the NetApp cluster management server.

- Username/Password

Credentials for the NetApp service user account that you have configured for Turbonomic to use.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in NetApp to those used in Turbonomic:

NetApp Name	Turbonomic Entity
Volume	Storage
Aggregate	Disk Array
Controller / Filer	Storage Controller

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory [Storage Supply Chain](#).

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
Storage	Move	Provision, Resize Up
Disk Array		Resize Up, Move, Provision
Storage Controller		Provision

Note that Turbonomic can automate moving a datastore to a disk array on the same storage controller, as well as moves to a disk array on a different storage controller.

Monitored Resources

Turbonomic monitors the following storage resources:

Note:

In NetApp environments, the storage controller shows 100% utilization when there are no more disks in a SPARE state that the storage controller can utilize in an aggregate. This does not indicate that the storage controller has no capacity.

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Disk Array

- Storage Amount
The utilization of the Disk Array's capacity.

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the Disk Array's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the disk array

Measured in Operations per second

- Latency

The utilization of latency, computed from the latency of each device in the disk array.

Measured in milliseconds (ms)

Storage Controller

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- CPU

The utilization of the Storage Controller's allocated CPU

Measured in Megahertz (MHz)

- Storage Amount

The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.

Measured in Megabytes (MB)

Restricted Service Accounts In NetApp

While Turbonomic prefers a NetApp service account with administrator rights, it is possible to create an account that has limited access, by following the steps outlined below, depending on NetApp mode.

NetApp 9.x Restricted Service Account Setup

If you prefer to use a service account that does not have full administrator rights:

1. Log into the NetApp filer from a command shell.
2. Create a role and assign it permission to execute each of the following commands:

For example:

```
security login role create -role RoleName -cmddirname "storage aggregate show" -vserver Cluster-Name
```

The required capabilities are listed below:

- cluster identity modify
- cluster identity show
- lun create
- lun igroup create
- lun igroup modify
- lun igroup show
- lun mapping create

- lun mapping delete
 - lun mapping show
 - lun modify
 - lun show
 - network interface create
 - network interface delete
 - network interface modify
 - network interface show
 - statistics show
 - storage aggregate create
 - storage aggregate modify
 - storage aggregate show
 - storage disk show
 - system controller flash-cache show
 - system node modify
 - system node show
 - version
 - volume create
 - volume modify
 - volume move modify
 - volume move show
 - volume move start
 - volume qtree create
 - volume qtree show
 - volume show
 - volume snapshot create
 - volume snapshot modify
 - volume snapshot show
 - vservers create
 - vservers fcp nodename
 - vservers iscsi nodename
 - vservers modify
 - vservers options
 - vservers show
3. For execution privileges, execute the following commands for the given role, where Role-Name is the name of the role you are creating, and Cluster-Name identifies the cluster you want the role to affect. You must execute these commands individually to set privileges that affect each individual cluster:
- security login role create -role Role-Name -access all -cmddirname "volume offline" -vservers Cluster-Name
 - security login role create -role Role-Name -access all -cmddirname "volume unmount" -vservers Cluster-Name
 - security login role create -role Role-Name -access all -cmddirname "volume move" -vservers Cluster-Name

- `security login role create -role Role-Name -access all -cmddirname "volume delete" -vserver Cluster-Name`
4. Create a user that will use the newly-created role.
For example:
`security login create -User-Name RoleUser -r TurbonomicRole`
 5. Enter a password for the new user when prompted.
 6. Give the user access to the `ssh` and `ontapi` applications by using the following commands, replacing `Role-Name` and `RoleUser` with the role and user you created:
`security login create -role Role-Name -username RoleUser -application ontapi -authmethod password`
`security login create -role Role-Name -username RoleUser -application ssh -authmethod password`

NetApp C-Mode Restricted Service Account Setup

If you prefer to use a service account that does not have full administrator rights:

1. Log into the NetApp filer from a command shell.
2. Create a role and assign it permission to execute each of the following commands:
 - `aggr-get-iter`
 - `igroup-get-iter`
 - `cluster-identity-get`
 - `lun-map-get-iter`
 - `net-interface-get-iter`
 - `storage-disk-get-iter`
 - `system-get-node-info-iter`
 - `volume-get-iter`
 - `vserver-get-iter`
 - `fcnode-get-name`
 - `flash-device-get-iter`
 - `iscsi-node-get-name`
 - `options-list-info`
 - `qtree-list-iter`
 - `system-get-version`
 - `lun-get-iter`
 - `snapshot-get-iter`
 - `perf-object-get-instances`
 - `volume-get-iter`
 - `volume-move-get-iter`
 - `volume-move-start`

For example, to enable volume offline, execute the following:

```
security login role create -role Role-Name -access all -cmddirname "volume
offline" -vserver <cluster_name>
```

3. Create a user based on the role you create.

Give the user access to the ssh and ontapi applications. For example:

```
security login create -role Role-Name -username User-Name -application ontapi -authmethod password
```

Pure Storage

Turbonomic supports management of the following Pure Storage technologies:

- FlashArray//C
- FlashArray//X

The following technologies are not supported:

- FlashBlade

Because of the improved performance of Pure Storage arrays, Turbonomic intelligently moves more demanding workloads to Flash-based datastores. Turbonomic analysis is also able to incorporate Pure Storage de-duplication and compression when recommending actions.

Prerequisites

- A service account Turbonomic can use to connect to the FlashArray

This account needs privileges to execute commands through the Pure Storage API — Typically the default `pureuser` administrative account.

Adding Pure Storage Targets

To add a Pure Storage target, select the **Storage > Pure Storage** option on the Target Configuration page and provide the following information:

- Address

The name or IP address of the Pure Storage FlashArray.

- Username/Password

Credentials for the service account Turbonomic can use to connect to the FlashArray. The Username must not contain the domain. For example, `Username=jjsmith` is correct, while `Username=myDomain\jjsmith` will result in a failure to validate.

- Secure connection

When checked, uses SSL to connect to the Pure target. Most Pure installations do not accept insecure connections. If you receive an error when adding the target with secure connections disabled, try re-adding with this option enabled.

After validating the new target, Turbonomic discovers the connected storage entities. This table compares terms used in Pure to those used in Turbonomic:

Pure Name	Turbonomic Entity
Volume	Storage
Shelf Array	Disk Array
Controller	Storage Controller

Supply Chain

Storage targets (storage controllers) add Storage Controller and Disk Array entities to the supply chain. Disk Array entities then host Storage entities (datastores). For a visual representation, see the introductory [Storage Supply Chain](#).

Supported Actions

For each discovered entity, Turbonomic can execute or recommend certain actions, as outlined below.

Entity Type	Can Be Automated	Recommendations only
Storage		Resize Up
Disk Array		
Storage Controller		Provision

Pure Storage assigns all the disks managed by a storage controller to a single array, with a fixed form-factor. There are no actions to perform for an array — For example, there is no action to move a disk array from one storage controller to another. Likewise, there are no actions to move or provision volumes because of the fixed form-factor.

Monitored Resources

Turbonomic monitors the following storage resources:

Storage

- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the datastore's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the datastore
Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency
The utilization of latency on the datastore
Measured in Milliseconds (ms)

Disk Array

- Storage Amount
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- Storage Provisioned

The utilization of the Disk Array's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the disk array

Measured in Operations per second

- Latency

The utilization of latency, computed from the latency of each device in the disk array.

Measured in milliseconds (ms)

Storage Controller

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- CPU

The utilization of the Storage Controller's allocated CPU

Measured in Megahertz (MHz)

- Storage Amount

The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.

Measured in Megabytes (MB)

Virtual Desktop Infrastructure Targets

A virtual desktop infrastructure target is a service that delivers digital workspaces to multiple application users through a single portal. When you connect Turbonomic to VDI targets, it monitors the performance and resource consumption of the business users utilizing the virtual desktops and the virtual desktop infrastructure itself. Turbonomic then performs Application Resource Management (ARM) using the enhanced data to assure application performance while also utilizing resources as efficiently as possible.

As part of this process, Turbonomic will use this information to provide deeper insight into the state of the hardware, and information related to the users and virtual desktops running in your environment.

Monitored Resources

Turbonomic monitors the following resources for the VDI supply chain:

Business User

- ImageCPU

CPU utilization, as a percentage of CPU capacity for the user's desktop image or images.

- ImageMem

Memory utilization, as a percentage of Memory capacity for the user's desktop image or images.

- ImageStorage

Storage utilization, as a percentage of storage capacity for the user's desktop image or images.

Desktop Pool

- Pool CPU

The CPU available to the pool that is in use by active sessions.

- **Pool Memory**
The memory available to the pool that is in use by active sessions.
- **Pool Storage**
The storage capacity available to the pool that is in use by active sessions.
- **Active Sessions**
How many active sessions are on the pool as a percentage of the pool's capacity as defined in the Turbonomic policy.
- **Total Sessions**
How many active and disconnected (non-terminated) sessions are on the pool, as a percentage of the pool's capacity.

Horizon

VMware Horizon provides end users access to all of their virtual desktops, applications, and online services through a single digital workspace.

With the information provided by Horizon, Turbonomic efficiently utilizes the VDI infrastructure to avoid inappropriately placed or sized desktops, ensure users are matched to desktop images that meet their demand, while gaining valuable insight into the interconnected nature of your environment.

Prerequisites

- Horizon 7.0 or higher
- The version of the vCenter target associated to the Horizon target must be 5.0+

Adding Horizon Targets

Note:

For each Horizon target, you must add only one connection server servicing that site. Turbonomic will use the default port of 443. Adding multiple connection servers for the same site will result in inconsistent and/or duplicate actions.

To add a Horizon target, select the **Virtual Desktop Infrastructure > Horizon** option on the Target Configuration page and provide the following information:

- **Address**
The IP address of the Horizon connection server.
- **Username**
Username for the user account Turbonomic will use to connect to the Horizon target. This account must be an Administrator (Read-Only) account.
- **Password**
Password for the user account Turbonomic will use to connect to the Horizon target.
- **vCenter Username**
Username for the user account Turbonomic will use to connect to the vCenter target related to Horizon. Leave this blank if the Horizon and vCenter credentials are identical.
- **vCenter Password**
Password for the user account Turbonomic will use to connect to the vCenter target related to Horizon. Leave this blank if the Horizon and vCenter credentials are identical.
- **LDAP Server**

The address of the specific LDAP server Turbonomic will use in conjunction with the Horizon target. By default, Turbonomic will do a lookup based on the domain entered in the Username and select a healthy DNS server from the response.

- **LDAP Server Port**

The port Turbonomic will use to connect to the specified LDAP server. By default, Turbonomic will use port 389 for unsecure connections, and port 636 for secure connections.

- **Secure LDAP Connection**

When checked, Turbonomic will use SSL to communicate to the LDAP Server

- **LDAP Username**

The username Turbonomic will use to connect to the LDAP Server, in the user principal name format to authenticate in the directory service through Kerberos. For example, `user.name@domain.com`

- **LDAP Password**

The password Turbonomic will use to connect to the LDAP Server

Actions

Under some circumstances, you can have users who need smaller or larger desktop images. This appears as users with low or high utilization of the image resources, respectively. You may also need to alleviate congestion on the desktop pool at certain times of day, based on usage. In these cases, Turbonomic can recommend moving the business user to a different desktop pool that serves up larger images.

To support these actions, you must configure a Workload Placement policy that merges the desktop pools. To do this:

- Create a new Workload Placement policy
- Choose Merge as the policy type
- For the consumer type to merge, choose Desktop Pool
- Choose the pools that you want to merge
- Save the policy

For more information, see [Creating Placement Policies](#) in the Turbonomic User Guide.

Turbonomic recommends actions for the various entities of the Horizon target as follows:

Business User

- Move Business User due to image congestion
- Move Business User due to desktop pool congestion

Desktop Pool

Turbonomic does not recommend actions to perform on a desktop pool. Instead, it recommends actions to perform on the business users running active sessions in the pool.

View Pod

Turbonomic does not recommend actions to perform on a view pod. Instead, it recommends actions to perform on the business users running active sessions in the view pod.

Monitored Resources

Turbonomic monitors the following commodities of the Horizon target:

Business User

- **ImageCPU**
CPU utilization, as a percentage of CPU capacity for the user's desktop image or images.
- **ImageMem**

Memory utilization, as a percentage of Memory capacity for the user's desktop image or images.

- ImageStorage

Storage utilization, as a percentage of storage capacity for the user's desktop image or images.

Desktop Pool

- Pool CPU

The CPU available to the pool that is in use by active sessions.

- Pool Memory

The memory available to the pool that is in use by active sessions.

- Pool Storage

The storage capacity available to the pool that is in use by active sessions.

- Active Sessions

How many active sessions are on the pool as a percentage of the pool's capacity as defined in the Turbonomic policy.

- Total Sessions

How many active and disconnected (non-terminated) sessions are on the pool, as a percentage of the pool's capacity.

View Pod

- Active Sessions

How many active sessions are on the pool as a percentage of the pool's capacity as defined in the Turbonomic policy.

- Total Sessions

How many active and disconnected (non-terminated) sessions are on the pool, as a percentage of the pool's capacity.

Appendix — Target Configuration

This appendix contains topics that are related to configuring Turbonomic targets.

Cisco Unified Computing System

UCS Blade Provisioning

When managing a UCS fabric target, Turbonomic can provision any blade servers that are installed in a chassis but not currently in operation. If the workload demands more physical compute resources, Turbonomic can automatically direct UCS to provision a blade, or it can recommend that you provision a blade and you can execute the action from the To Do list. To enable this capability, you must perform two basic steps:

- Configure the way UCS and vCenter Server manage information as blades are provisioned

To enable Turbonomic to perform automatic provisioning of UCS blades, you must configure UCS to work with vCenter Server as they both manage resources such as server pools, policies, and Service Profile Templates. This ensures that as Turbonomic directs the UCS Manager to provision a new blade, vCenter Server will recognize that the new physical host is available. Once vCenter Server can recognize the new blade, Turbonomic can direct vCenter Server to move workloads onto the server.

Turbonomic provisions new blades based on the service profiles of operating blades. To enable this, the configuration must include Service Profile Templates, and the operating blades must be bound to these templates.

For information about configuration that enables automated provisioning of blades, see the Cisco Communities post, “UCS PowerTool and VMware PowerCLI automated management of Auto-deploy” at the following location:

https://communities.cisco.com/community/technology/datacenter/ucs_management/cisco_ucs_developed_integrations/blog/2013/09/16/ucs-powertool-and-vmware-powercli-automated-management-of-auto-deploy

This post includes a video that shows “a joint PowerShell integration utilizing both Cisco UCS PowerTool and VMware PowerCLI.” You can also download the scripts from this post and modify them as necessary for your deployment.

- Set the Host Provision action to Automate or Manual for the blade servers. By default, Turbonomic sets the Host Provision action to Recommend.

For any hosts other than blade servers managed by UCS, Turbonomic cannot provision hosts automatically or manually. Instead, it recommends that you provision a host, and you then install the physical machine and wire it to the network.

In a UCS deployment you can have blade servers installed in the chassis and ready to provision. In that case, Turbonomic can direct UCS to provision a new blade to meet workload demands. For these servers, you can set the Host Provision action to Automatic or Manual.

Note:

It's important that you only set Automatic or Manual host provisioning to UCS blades. If you set Host Provision to Automatic for other types of hosts, Turbonomic will attempt to perform the action and fail. As a result, you might never see the recommendation to provision a new host of that type.

Turbonomic groups blade servers by chassis. To restrict Automatic or Manual settings to blade servers, use this group. You can set the action mode for all blade servers in your environment, or you can set the mode differently for individual chassis.

Enabling Collection of Memory Statistics: AWS

So Turbonomic can collect memory statistics in your AWS environment, you must set up your VMs to publish statistics via CloudWatch. Some of the steps to do this are different depending on whether your VM is running a Linux or Windows OS.

To enable memory statistics on your VMs, you must meet the following requirements:

- The VM image must have an SSM agent installed

- Linux VMs:

By default, Linux AMIs dated 2017.09 and later include an installed SSM Agent.

- Windows VMs:

You must install the SSM agent on the VMs. For more information, see [Working with SSM Agent](#).

- Access to the CloudWatch service

Your AWS Instance must have internet access or direct access to CloudWatch so it can push data to CloudWatch.

- Access from Turbonomic

For Turbonomic to access the memory data, the account that it uses to connect to the AWS target must include the correct permissions. If you configured the AWS target via an AWS key (not an IAM role), then you must include the permissions as specified in the section for configuring an AWS target.

If you use an IAM role for the Turbonomic connection, then that role must include the following as a minimum:

- AmazonEC2ReadOnlyAccess

- AmazonS3ReadOnlyAccess

To set up the collection of memory statistics for your VMs:

1. Attach an IAM role to each VM instance.

Each EC2 instance must have an attached IAM role that grants CloudWatch access. To grant that access, we suggest you include the AmazonSSMFullAccess policy in the role.

Use the AWS System Manager to attach the necessary roles to your VMs.

Note:

If you want to grant the role lesser access, you can use the AmazonEC2RoleforSSM policy. This is a custom policy that allows the action `ssm:GetParameter` to access the resource, `arn:aws:ssm:*:*:parameter/*`.

2. Install the CloudWatch agent on your Linux VMs.

Navigate to the AWS System Manager service for the account and region that you want to configure. In the service, navigate to the **Run Command** screen and set up the **AWS-ConfigureAWSPackage** command to install **AmazonCloudWatchAgent** on your VMs. For more information, please see the AWS documentation.

3. Create configuration data for the CloudWatch agent.

The configuration data is a JSON object that you will add to as a parameter to the Parameter Store. The object must include the following, depending on whether it's for a Linux or a Windows VM instance.

• **Linux Configuration:**

```
{
  "agent": {
    "metrics_collection_interval": 60,
    "logfile": "/opt/aws/amazon-cloudwatch-agent/logs/amazon-cloudwatch-agent.log"
  },
  "metrics": {
    "namespace": "custom",
    "metrics_collected": {
      "mem": {
        "measurement": [
          {
            "name": "mem_available", "rename": "MemoryAvailable", "unit": "Bytes"
          }
        ]
      }
    },
    "append_dimensions": {
      "AutoScalingGroupName": "${aws:AutoScalingGroupName}",
      "ImageId": "${aws:ImageId}",
      "InstanceId": "${aws:InstanceId}",
      "InstanceType": "${aws:InstanceType}"
    }
  }
}
```

• **Windows Configuration:**

```
{
  "metrics": {
    "namespace": "Windows System",
    "append_dimensions": {
      "InstanceId": "${aws:InstanceId}"
    },
    "aggregation_dimensions": [ ["InstanceId"] ],
    "metrics_collected": {
      "Memory": {
        "measurement": [
          {
            "name": "Available Bytes", "rename": "MemoryAvailable", "unit": "Bytes"
          }
        ],
        "metrics_collection_interval": 60
      },
      "Paging File": {
        "measurement": [
          {
            "name": "% Usage", "rename": "paging_used"
          }
        ]
      }
    }
  }
}
```



```

    ],
    "metrics_collection_interval": 60,
    "resources": [
        "*"
    ]
  }
}
}
}

```

Note that you can configure optional parameters for the CW Namespace and region. However, if you configure more metrics for CloudWatch to collect, these metrics do not affect Turbonomic analysis and they do not show up in the user interface. Turbonomic only tracks Used Memory statistics.

4. Create a parameter store.

a. Create a parameter.

In the AWS System Manager, navigate to **Parameter Store** and create a parameter. Copy and paste the JSON agent configuration (created above) into the parameter **Value** field.

b. Name the parameter

For example, AmazonCloudWatch-MyMemoryParam. You can use a different name, but per the Amazon documentation, the name *must* begin with AmazonCloudWatch. For more information, see [Store the CloudwatchConfig File in Parameter Store](#).

You must remember this parameter name.

c. Click to create the parameter.

5. Deploy the CloudWatch parameter to your VMs.

In the AWS System Manager, navigate to the **Run Command** screen to configure and run the **AmazonCloudWatch-ManagedAgent** command. The configuration should include:

- **Action:** configure
- **Mode:** ec2
- **Optional Configuration Source:** ssm
- **Optional Configuration Location:** Give the name of the parameter that you created above.
- **Optional Restart:** yes (this restarts the CloudWatch Agent, not the VM instance)
- **Targets:** The VMs that you will deploy the CloudWatch configuration to

When the command is configured, run it. This configures collection of memory metrics for your instances.

6. Verify that you are collecting Memory metrics for your instances.

Navigate to the CloudWatch page, and display **Metrics** in the **CWAgent** namespace. Then inspect the instances by ID to verify that you can see MemoryAvailable metrics.

For more information about enabling memory statistics for AWS, see the following Green Circle articles:

- For Linux:

[Setting up CloudWatch Memory Metrics on Linux Instances on AWS](#).

- For Windows:

[“AWS Memory Stats - Windows”](#).

Enabling Collection of Memory Statistics: Azure

For Turbonomic to collect memory statistics in Azure, you must enable the collection of these statistics on the VMs in your environment. You can do this as you deploy your VMs, or you can enable the counters after the fact on VMs you have already deployed. For each VM, open the Azure Portal and navigate to Diagnostics Settings. Then enable the metrics for your VMs:

To enable the collection of memory statistics in Azure environments, open the Azure Portal, and then navigate to **Diagnostic Settings**. Then enable the metrics for your VMs:

- For Windows VMs

Navigate to **Performance Counters**, display **Basic**, and enable the performance counters for the VM.

- For Linux VMs

For supported Linux versions, Azure automatically deploys the Linux Diagnostics Extension v2.3 to gather these metrics. Refer to Microsoft Azure documentation for supported Linux OS versions. For unsupported versions, you can enable the statistics manually:

1. Set **Status** to ON.
2. For **Storage Account**, specify the storage that will retain the metric data.
3. Enable **Basic Metrics** and then click **Save**.
4. Navigate to **Metrics** in the Azure Portal and enable the metrics to collect.

For more information about enabling memory statistics for Azure, see the Green Circle article, [“How to Enable Memory Metrics on Azure Manually”](#).

GCP Target Service Account

This appendix guides you through the steps to create a valid service account that Turbonomic can use to connect with a GCP operational target. The access you grant to this service account determine the access Turbonomic has to discover and manage entities in your GCP infrastructure. To create this account you will:

- Create a service account in GCP
- Generate key file for the service account
- Create custom roles for the project(s) you want Turbonomic to manage
- Add the custom roles to the GCP Service Account, plus the predefined Billing Account Viewer role

Create a Service Account in GCP

Open a `gcloud shell` session in the project that you want to host the new Service Account. In `gcloud shell`, execute the following command, where:

- `$SERVICE_ACCOUNT_ID` is the unique alphanumeric ID that you assign to this service account
- `$SERVICE_ACCOUNT_DISPLAY_NAME` is the display name that you want for the service account

```
$ gcloud iam service-accounts create $SERVICE_ACCOUNT_ID \
  --display-name="$SERVICE_ACCOUNT_DISPLAY_NAME" \
  --format=text --quiet
```

When you execute the command, the shell should display the following output:

```
displayName:    <SERVICE_ACCOUNT_DISPLAY_NAME>
email:          <SERVICE_ACCOUNT_EMAIL>
etag:          MDEwMjE5MjA=
name:          <SERVICE_ACCOUNT_NAME>
projectId:     <SA_DEFAULT_PROJECT>
uniqueId:      102200949905427524050
```

Note the following fields in the output for later use:

- email
- name
- projectId

Note:

The `projectId` field identifies the project that hosts this Service Account. You should note that project for future reference, in case you want to review or edit the Service Account.

Generate the Key File

To generate the key file, execute the following command in the `gcloud` shell:

```
$ gcloud iam service-accounts keys create $SA_KEY_FILE_NAME \
  --iam-account=$SERVICE_ACCOUNT_EMAIL
```

Be sure to save the key file – you need it when you configure the GCP Target in Turbonomic.

Create Custom Roles

You must create two different roles for access to your GCP projects and organization, and you can create a third role for permission to execute actions in projects.

Note:

To target specific folders, define a custom role at the organization level. It is not possible to define custom roles at the folder level.

1. Project Access Role:

In a location you can access from your `gcloud` shell session, create a file named `TurbonomicSaAccessProject.yaml`. Edit the file to have the following content:

```
title: "Turbonomic Role: Min Accecss - Project"
description: "Minimal Required Permissions for Turbonomic to manage the GCP Project"
stage: "ALPHA"
includedPermissions:
# discovery
- resourceManager.projects.get
- compute.regions.list
- compute.zones.list
- compute.machineTypes.list
- compute.machineTypes.get
- compute.disks.list
- compute.disks.get
- compute.diskTypes.list
- compute.instances.list
- compute.instances.get
- compute.instanceGroupManagers.list
- compute.instanceGroupManagers.get
# CUD
- compute.commitments.list
# Metrics Monitoring
- logging.views.list
- logging.views.get
- monitoring.services.get
- monitoring.services.list
- monitoring.timeSeries.list
```

Then execute the following command to create the custom role in your organization, where you substitute `TurbonomicSaAccessProject.yaml` with the path to your yaml file:

```
$ gcloud iam roles create $CUSTOM_ROLE_NAME \
  --project=$PROJECT_ID \
  --file=TurbonomicSaAccessProject.yaml
```

In the resulting console output, note the role name. You need that name to add the role to your service account.

2. Organization Access Role:

In a location you can access from your `gcloud` shell session, create a file named `TurbonomicSaAccessOrg.yaml`. Edit the file to have the following content:

```
title: "Turbonomic Role: Access - Organization"
description: "Minimal Required Permissions for Turbonomic to access the GCP Organization"
```

```
stage: "ALPHA"
includedPermissions:
# Organization Structure View
- resourcemanager.organizations.get
- resourcemanager.projects.list
- resourcemanager.projects.get
- resourcemanager.folders.list
- resourcemanager.folders.get
- billing.resourceAssociations.list
```

Then execute the following command to create the custom role in your organization, where you substitute `TurbonomicSaAccessOrg.yaml` with the path to your yaml file:

```
$ gcloud iam roles create $CUSTOM_ROLE_NAME \
  --organization=$ORGANIZATION_ID \
  --file=TurbonomicSaAccessOrg.yaml
```

In the resulting console output, note the role name. You need that name to add the role to your service account.

3. Project Action Role:

Create this role if you want Turbonomic to execute actions in your GCP environment.

In a location you can access from your `gcloud` shell session, create a file named `TurbonomicSaProjectAction.yaml`. Edit the file to have the following content:

```
title: "Turbonomic Role: Project Action Execution"
description: "Grant Turbonomic to execute actions in the GCP Project"
stage: "ALPHA"
includedPermissions:
# Action Execution
- compute.globalOperations.get
- compute.instances.setMachineType
- compute.instances.start
- compute.instances.stop
- compute.regionOperations.get
- compute.zoneOperations.get
```

Then execute the following command to create the custom role in your organization, where you substitute `TurbonomicSaProjectAction.yaml` with the path to your yaml file:

```
$ gcloud iam roles create $CUSTOM_ROLE_NAME \
  --project=$PROJECT_ID \
  --file=TurbonomicSaProjectAction.yaml
```

In the resulting console output, note the role name. You need that name to add the role to your service account.

Add Custom Roles to the Service Account

You will now add the three roles you created to your Service Account, plus the predefined Billing Viewer role.

1. (Required) Add the predefined Billing Viewer role.

In the GCP Console, go to **Billing > Account Management**. This page should display the billing account and project you are going to use as the GCP Billing Target in Turbonomic.

Add the **Billing Account Viewer** role to the Service Account

2. (Required) Add the *Organization Access* role that you created for the Service Account.

In the `gcloud` console session, execute this command, where `$ROLE_NAME` is the role name you noted when you created the Organization Access role:

```
$ gcloud projects add-iam-policy-binding $PROJECT_ID \
  --member=serviceAccount:$SERVICE_ACCOUNT_EMAIL --role=$ROLE_NAME
```

3. (Required) Add the *Project Access* role that you created for the Service Account.

In the `gcloud` console session, execute this command, where `$ROLE_NAME` is the role name you noted when you created the Project Access role:

```
$ gcloud projects add-iam-policy-binding $PROJECT_ID \
  --member=serviceAccount:$SERVICE_ACCOUNT_EMAIL --role=$ROLE_NAME
```

4. (Optional) Add the *Project Action* role that you created for the Service Account.

You only need to add this role if you want Turbonomic to execute actions in your GCP project.

In the `gcloud` console session, execute this command, where `$ROLE_NAME` is the role name you noted when you created the Project Action role:

```
$ gcloud projects add-iam-policy-binding $PROJECT_ID \
  --member=serviceAccount:$SERVICE_ACCOUNT_EMAIL --role=$ROLE_NAME
```

You now have created a Service Account that you can use to configure your GCP operational target.

GCP Billing Target Service Account

This appendix guides you through the steps to create a valid service account that Turbonomic can use to connect with a GCP billing target. To create this account you will:

- Create a service account in GCP
- Generate key file for the service account
- Create a custom role in the project(s) you want Turbonomic to manage
- Add the created custom role to the GCP Service Account, plus the predefined Billing Account Viewer role

Create a Service Account in GCP

Open a `gcloud` shell session in the project that you want to host the new Service Account. In `gcloud` shell, execute the following command, where:

- `$SERVICE_ACCOUNT_ID` is the unique alphanumeric ID that you assign to this service account
- `$SERVICE_ACCOUNT_DISPLAY_NAME` is the display name that you want for the service account

```
$ gcloud iam service-accounts create $SERVICE_ACCOUNT_ID \
  --display-name="$SERVICE_ACCOUNT_DISPLAY_NAME" \
  --format=text --quiet
```

When you execute the command, the shell should display the following output:

```
displayName: <SERVICE_ACCOUNT_DISPLAY_NAME>
email: <SERVICE_ACCOUNT_EMAIL>
etag: MDEwMjE5MjA=
name: <SERVICE_ACCOUNT_NAME>
projectId: <SA_DEFAULT_PROJECT>
uniqueId: 102200949905427524050
```

Note the following fields in the output for later use:

- email
- name
- projectId

Note:

The `projectId` field identifies the project that hosts this Service Account. You should note that project for future reference, in case you want to review or edit the Service Account.

Generate the Key File

To generate the key file, execute the following command in the `gcloud` shell:

```
$ gcloud iam service-accounts keys create $SA_KEY_FILE_NAME \
  --iam-account=$SERVICE_ACCOUNT_EMAIL
```

Be sure to save the key file – you need it when you configure the GCP Billing Target in Turbonomic

Create a Custom Billing Role

In a location you can access from your `gcloud` shell session, create a file named `TurbonomicSaBilling.yaml`. Edit the file to have the following content:

```
title: "Turbonomic Billing Data Viewer Role"
description: "Minimal Required Permissions for Turbonomic to view billed cost and pricing
stored in the GCP Project"
stage: "ALPHA"
includedPermissions:
- bigquery.tables.get
- bigquery.tables.getData
- bigquery.tables.list
- bigquery.jobs.create
# derived cost probe will need
- compute.regions.list
- compute.zones.list
- compute.commitments.list
- compute.diskTypes.list
- compute.machineTypes.list
```

Then execute the following command to create the custom role in your organization, where you substitute `TurbonomicSaBilling.yaml` with the path to your yaml file:

```
$ gcloud iam roles create $CUSTOM_ROLE_NAME \
  --project=$PROJECT_ID \
  --file=TurbonomicSaBilling.yaml
```

In the resulting console output, note the role name. You need that name to add the role to your service account.

Add the Custom Roles to the Service Account

You will now add the Custom Billing role you created to your Service Account, plus the predefined Billing Viewer role.

1. (Required) Add the predefined Billing Viewer role.

In the GCP Console, go to **Billing > Account Management**. This page should display the billing account and project you are going to use as the GCP Billing Target in Turbonomic.

Add the **Billing Account Viewer** role to the Service Account

2. (Required) Add the *Custom Billing* role that you created for the Service Account.

In the `gcloud` console session, execute this command, where `$ROLE_NAME` is the role name you noted when you created the Custom Billing role:

```
$ gcloud projects add-iam-policy-binding $PROJECT_ID \
  --member=serviceAccount:$SERVICE_ACCOUNT_EMAIL --role=$ROLE_NAME
```

You now have created a Service Account that you can use to configure your GCP Billing Target.

Enabling Windows Remote Management

Turbonomic communicates with your Hyper-V servers using Web Services Management (WS-Management), which is implemented on Microsoft platforms using Windows Remote Management (WinRM). The following steps show how to enable WinRM on a single host, using the command line.

1. Ensure Windows Firewall is running on the host.

For you to configure WinRM successfully, Windows Firewall must be running on the host. For more information, see the Microsoft Knowledge Base article #2004640 (<http://support.microsoft.com/kb/2004640>).

2. Set up an SPN for the host machine.

The machine must have an SPN of the form, `protocol/host_address`. For example, `WSMAN/10.99.9.2`.

To get a list of SPNs for the machine, execute the following in the command window:

```
setspn -l <vmm-server-name>
```

If there is no valid SPN in the list, create one by running the command:

```
setspn -A protocol/host-address:port where port is optional
```

For example, `setspn -A WSMAN/10.99.9.2:VMM-02`

3. Set up the Windows Remote Management (WinRM) service to run on startup.

Run the `quickconfig` utility to set up the WinRM service. The `quickconfig` utility:

- Configures the WinRM service to auto-start
- Configures basic authentication and disables unencrypted traffic
- Creates a firewall exception for the current user profile
- Configures a listener for HTTP and HTTPS on any IP address
- Enables remote shell access

To run `quickconfig`, log into a command window as Administrator on the host machine. Then execute the following commands:

```
winrm quickconfig
```

Enter `y` to accept the `quickconfig` changes

4. Set permissions on the host machine.

Execute the following commands in the command window to modify the settings made by `quickconfig`:

- To set the memory capacity for remote shells:

```
winrm set winrm/config/winrs @{MaxMemoryPerShellMB="1024"}
```

- To set up an unsecured HTTP connection:

```
winrm set winrm/config/service @{AllowUnencrypted="true"}
```

```
winrm set winrm/config/service/Auth @{Basic="true"}
```

These steps showed you how to enable WinRM for a single host. Some users find the following methods useful for enabling WinRM on multiple hosts:

- [EnablingWinRmViaGlobal Policy Objects](#)
- [EnablingWinRMViaPowerShell](#)

Enabling WinRM Via Global Policy Objects

You can configure WinRM for all of your Hyper-V targets by creating and linking a Global Policy Object (GPO) within the Hyper-V domain and applying the GPO to all servers.

Follow the steps below to enable Windows Remote Management (WinRM) for your Hyper-V targets.

1. On the AD domain controller, open the Group Policy Management Console (GPMC). If the GPMC is not installed, see <https://technet.microsoft.com/en-us/library/cc725932.aspx>.
2. Create a new Global Policy Object:

- a. In the GPMC tree, right-click **Group Policy Objects** within the domain containing your Hyper-V servers.
- b. Choose **Create a GPO in this domain**, and link it here.
- c. Enter a name for the new GPO and click **OK**.
3. Specify the computers that need access:
 - a. Select the new GPO from the tree.
 - b. On the **Scope** tab, under **Security Filtering**, specify the computer or group of computers you want to grant access. Make sure you include all of your Hyper-V targets.
4. Right-click the new GPO and choose **Edit** to open the Group Policy Management Editor.
5. Configure the WinRM Service:
 - a. In the Group Policy Management Editor, select **Computer Configuration > Policies > Administrative Templates > Windows Components > Windows Remote Management (WinRM) > WinRM Service**.
 - b. Double-click each of following settings and configure as specified:

Allow automatic configuration of listeners ("Allow remote server management through WinRM" on older versions of Windows Server):	Enabled IPv4 filter: *
Allow Basic authentication:	Enabled
Allow unencrypted traffic:	Enabled

6. Configure the WinRM service to run automatically:
 - a. In the Group Policy Management Editor, expand **Computer Configuration > Preferences > Control Panel Settings**.
 - b. Under Control Panel Settings, right-click Services and choose **New > Service**.
 - c. In the New Service Properties window, configure the following settings:

Startup:	Automatic
Service name:	WinRM
Service option:	Service start

7. Enable Windows Remote Shell:
 - a. In the Group Policy Management Editor, select **Computer Configuration > Policies > Administrative Templates > Windows Components > Windows Remote Shell**.
 - b. Double-click the following setting and configure as specified:

Allow Remote Shell Access:	Enabled
----------------------------	---------

8. Add a Windows Firewall exception:
 - a. In the Group Policy Management Editor, open **Computer Configuration > Windows Settings > Security Settings > Windows Firewall > Windows Firewall**.
 - b. Under Windows Firewall, right-click **Inbound Rules** and choose **New > Rule**.
 - c. In the New Inbound Rule Wizard, select **Predefined: Windows Remote Management and Allow the connection**.

The new group policy will be applied during the next policy process update. To apply the new policy immediately, execute the following command at a Powershell prompt:


```
gpupdate /force
```

Enabling WinRM Via PowerShell

Using PsExec, you can run quickconfig on all your Hyper-V servers and change the default settings remotely. PsExec is a component of PsTools, which you can download from <https://technet.microsoft.com/en-us/sysinternals/bb897553.aspx>.

1. Create a text file containing the Hyper-V host names, for example:

```
hp-vx485
```

```
hp-vx486
```

2. Since IBM requires changes to the default quickconfig settings, create a batch file containing the following command:

```
@echo off Powershell.exe Set-WSManQuickConfig -Force Powershell.exe Set-Item  
WSMan:\localhost\Shell\MaxMemoryPerShellMB 1024
```

Note:

If you are connecting via HTTP, you must include the following command:

```
Powershell.exe Set-Item WSMan:\localhost\Service\AllowUnencrypted -Value  
$True
```

3. Use PsExec to enable WinRM on the remote servers:

```
.\PsExec.exe @<hosts_file_path> -u <username> -p <password> -c  
<batch_file_path>
```

Note:

If you get an error message when executing this command, add the -h option (.\PsExec.exe -h).

Secure Setup of WSMan

Turbonomic provides a secure option for Hyper-V/VMM Targets which requires that WSMan be set up securely. Use PowerShell to generate a self-signed certificate, and create an HTTPS WinRM listener.

Note:

For clustered Hyper-V targets, you do not need to create a listener on each host. Only create a listener on the host that is being added to the "Address" field in the Target Configuration.

To enable secure WSMan on your Hyper-V host:

1. Generate a self-signed certificate using the following command:

```
New-SelfSignedCertificate -CertstoreLocation Cert:\LocalMachine\My -DnsName  
"myhost.example.org"
```

2. Find the thumbprint for the certificate for the host:

```
Get-ChildItem cert:\LocalMachine\My
```

3. Create an HTTPS WinRM listener for the host with the thumbprint you've found:

```
winrm create winrm/config/Listener?  
Address=**Transport=HTTPS '@{Hostname="myhost.example.org";  
CertificateThumbprint="THUMBPRINT_YOU_FOUND"}'
```

4. Verify the presence of configured listeners:

```
Get-WSManInstance -ResourceURI winrm/config/listener -Enumerate
```

Port Configuration

To support communication between Turbonomic and the API endpoints of your intended target, provide bidirectional access for the following ports:

Note:

This list may include targets not available to your version or distribution of Turbonomic.

Target	Port(s)
Vcenter (Monitoring)	443
Vcenter (Tags)	10443
Vcenter (Kubernetes)	88
Hyper-V	5985, 5986
Hyper-V (Kubernetes)	88
XenCenter	80, 443
VMM	5985, 5986
CloudFoundry	80, 443
VMAX	5988, 5989
Dell Compellent	5988, 5989
Nutanix	9440
XtremIO	80, 443
Pure	80, 443
HPE 3PAR	5988, 5989, 8080
NetApp	80, 443
NetScaler	80, 443
Cisco UCS	80, 443
sFlow	80, 443
Netflow	80, 443
Arista	80, 443
WebSphere	8880
WebLogic	7001
Tomcat	1009

Target	Port(s)
JBOSS	9990
Oracle	1521
SQL Server	1433
MySQL	3306
Horizon	443

Chapter 7. User Interface Reference

Turbonomic is the only solution that assures application performance for any workload running in any virtualized or cloud environment. Getting started with Turbonomic is very easy:

If you want to run an instance of the product in your environment:

- Download the Turbonomic VM
- Start the VM in your datacenter
- Open the Turbonomic user interface in a Web browser
- Specify targets that Turbonomic attaches to so it can discover, monitor, and control your datacenter inventory

If you want Turbonomic to host your instance:

- Log into the OnBoarding page
- Request a Turbonomic account
- Open the Turbonomic user interface in a Web browser
- Specify targets that Turbonomic attaches to so it can discover, monitor, and control your cloud accounts and subscriptions

After setting up, you can see the results of Turbonomic analysis — actions to perform that directly improve your datacenter state — within 15 to 30 minutes.

While it's true that setup is straightforward, the Turbonomic platform is rich in its coverage. Analysis takes your full stack into account, and Turbonomic recommends actions before alarms go off and the situation becomes critical. The user interface for such a product is necessarily rich with high-level information as well as fine details. You can use this interface and drill down to specific details that clarify the actions Turbonomic recommends.

IBM also understands the need to define business rules in your environment. For example, you might need to ensure that certain applications have exclusive access to “golden” storage, while others can use less expensive resources. Or, you might want to ensure that certain applications suspend at scheduled times (see [Scheduling VM Suspend Actions in the Public Cloud](#)). Turbonomic automation supports this kind of business rule, as well as HA, affinity, Pricing Adjustments, RI Purchase Profiles, and many other rules that you expect to set up in a modern datacenter. The user interface includes tools to configure Turbonomic so that action recommendations respect the needs within your environment.

This reference material describes Turbonomic and its user interface. If you have any questions about what you see in the user interface, or how to use the tools that Turbonomic offers, we hope you will find this material useful.

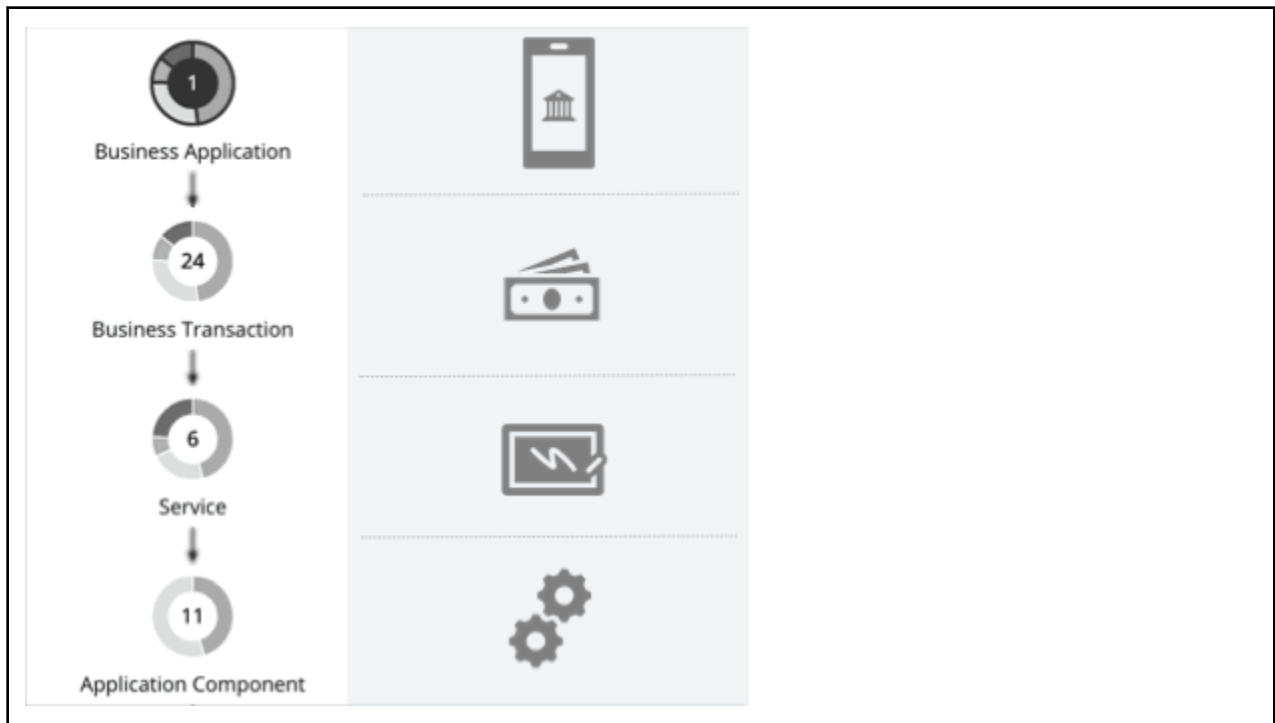
Entity Types - Applications

The supply chain strongly emphasizes our application-driven approach to managing your infrastructure. By showing the entity types that make up your applications at the top of the hierarchy, it is easier for you to see the health of your environment and evaluate actions from the perspective that matters — Application Performance.



Business Application

A Business Application is a logical grouping of Business Transactions, Services, Application Components, and other elements of the application model that work together to compose a complete application as end users would view it. For example, a mobile banking app is a Business Application with a *Business Transaction* that facilitates payments, a *Service* within the Business Transaction that records payment information, and underlying *Application Components* (such as JVMs) that enable the Service to perform its functions.



You can monitor overall performance, make resourcing decisions, and set policies in the context of your Business Applications.

Note:

The supply chain also models Turbonomic as a Business Application so you can monitor the performance of the product. For details, see [Turbonomic as a Business Application](#).

Synopsis

Synopsis	
Budget:	Business Applications have unlimited budget.
Provides:	The complete application to end users
Consumes from:	Business Transactions, Services, Application Components, Database Servers, and the underlying nodes
Discovery:	<p>Turbonomic discovers the following:</p> <ul style="list-style-type: none">• AppDynamics Business Applications• Dynatrace Applications <p>If you do not have these targets, you can create your own Business Applications using the Application Topology feature. For details, see Application Topology.</p>

Monitored Resources

Turbonomic monitors the following:

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second

The **Response Time** and **Transaction** charts for a Business Application show average and peak/low values over time. You can gauge performance against the given SLOs. By default, Turbonomic estimates SLOs based on monitored values. You can set your own SLO values in policies.

Actions**None**

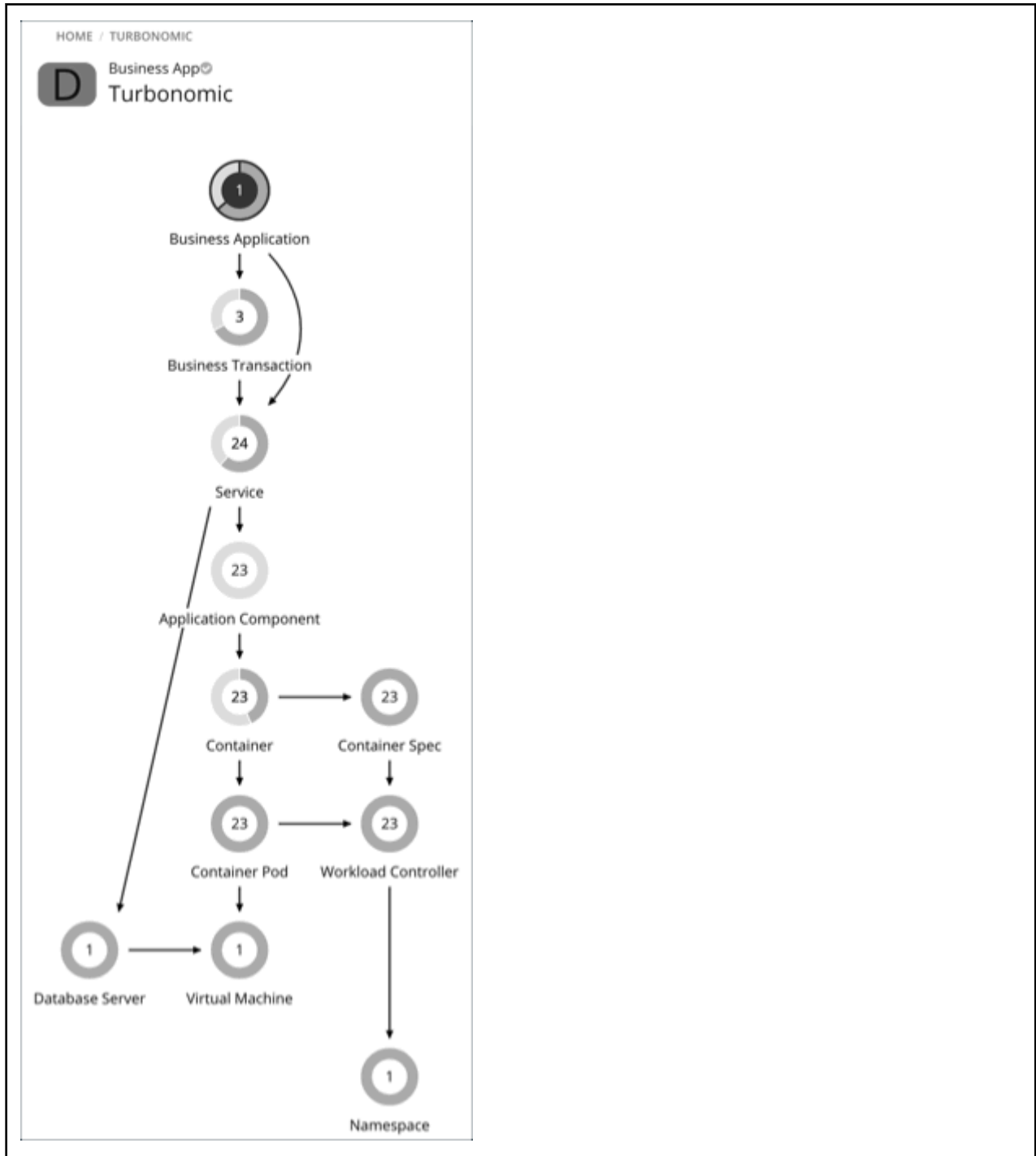
Turbonomic does not recommend actions for a Business Application, but it does recommend actions for the underlying Application Components and infrastructure. The Pending Actions chart for a Business Application lists these actions, thus providing visibility into the risks that have a direct impact on the Business Application's performance.

Turbonomic as a Business Application

The supply chain models Turbonomic as a Business Application. When you scope to the Turbonomic entity, you can see the Business Transactions, Services, and Application Components that make up the product, the underlying nodes (such as the product's VM and database server), as well as performance metrics.

Note:

After deploying Turbonomic, it might take at least ten minutes before it appears in the supply chain as a Business Application.



Key Business Transactions, Services, and Application Components work together to:

- Analyze your environment continuously
- Recommend actions to assure performance and reduce cloud costs
- Keep the supply chain up-to-date
- Run plans against the current environment

The Pending Actions chart at every level of the application model shows actions for the underlying Application Components and nodes, thus providing visibility into the risks that have a direct impact on the product's performance.

Business Application Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

None

Turbonomic does not recommend actions for a Business Application, but it does recommend actions for the underlying Application Components and infrastructure. The Pending Actions chart for a Business Application lists these actions, thus providing visibility into the risks that have a direct impact on the Business Application's performance.

Transaction SLO

Enable this SLO if you are monitoring performance through your Business Applications.

Attribute	Default Setting/Value
Enable Transaction SLO	Off Turbonomic estimates SLO based on monitored values.
Transaction SLO	None If you enable SLO, Turbonomic uses the default value of 10. You can change this to a different value.

Transaction SLO determines the upper limit for acceptable transactions per second. When the number of transactions reaches the given value, Turbonomic sets the risk index to 100%.

Response Time SLO

Enable this SLO if you are monitoring performance through your Business Applications.

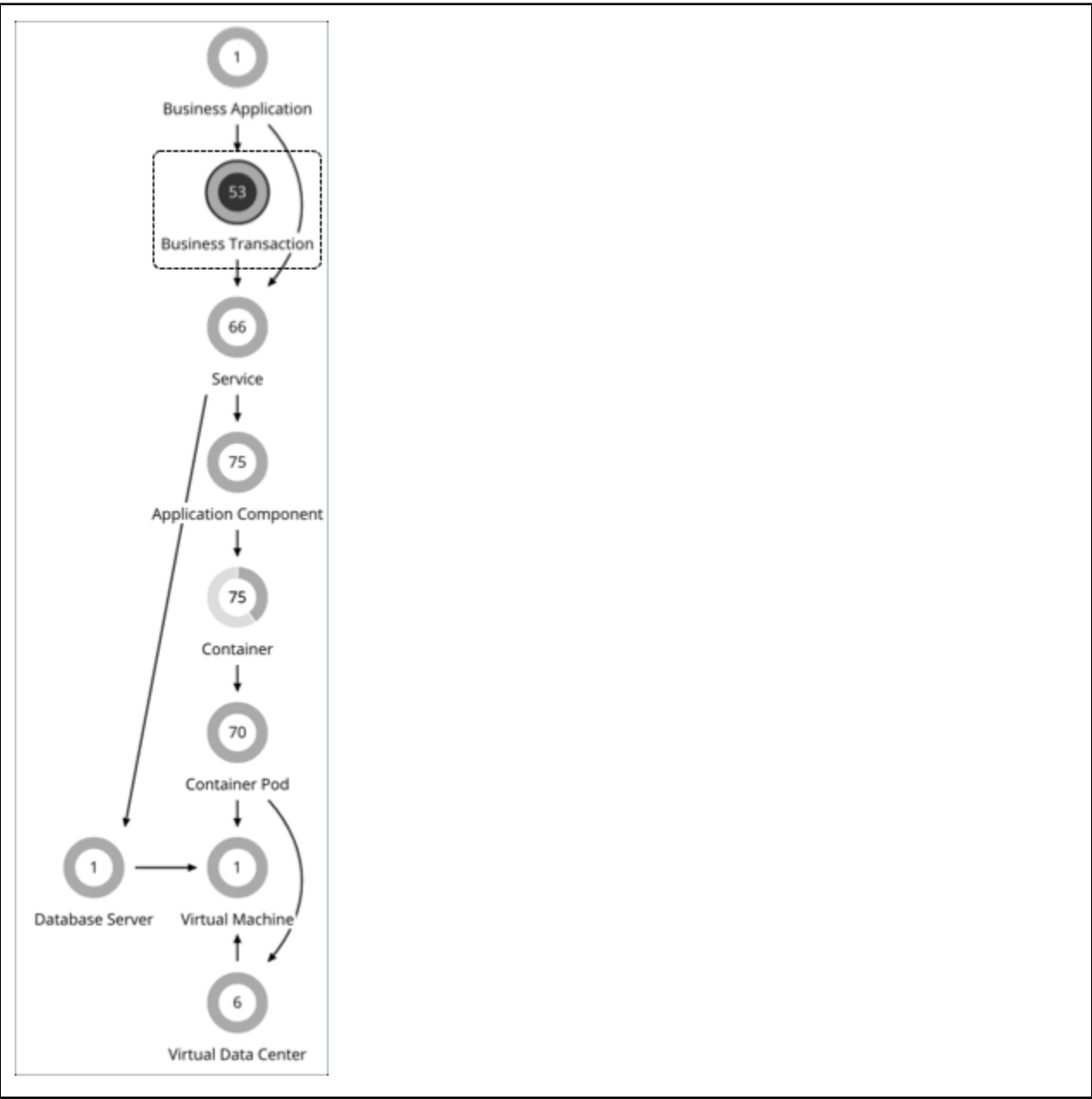
Attribute	Default Setting/Value
Enable Response Time SLO	Off Turbonomic estimates SLO based on monitored values.
Response Time SLO [ms]	None If you enable SLO, Turbonomic uses the default value of 2000. You can change this to a different value.

Response time SLO determines the upper limit for acceptable response time (in milliseconds). If response time reaches the given value, Turbonomic sets the risk index to 100%.

Business Transaction

A Business Transaction represents a capability within your Business Application that fulfills a response to a user-initiated request. Its performance directly impacts user experience. You can monitor performance as experienced by your end users in the context of Business Transactions. For more information, see [Business Application](#).

Synopsis



Synopsis	
Budget:	Business Transactions have unlimited budget.
Provides:	Response time and transactions to Business Applications
Consumes from:	Services , Application Components , Database Servers, and the underlying nodes
Discovery:	<p>Turbonomic discovers the following:</p> <ul style="list-style-type: none">• AppDynamics Business Transactions• NewRelic Key Transactions <p>If you do not have these targets, you can create your own Business Transactions using the Application Topology feature. For details, see Application Topology.</p>

Monitored Resources

Turbonomic monitors the following:

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Transactions

The utilization of the allocated transactions per second for the given business transaction

Measured in transactions per second

The **Response Time** and **Transaction** charts for a Business Transaction show average and peak/low values over time. You can gauge performance against the given SLOs. By default, Turbonomic estimates SLOs based on monitored values. You can set your own SLO values in policies.

Actions

None

Turbonomic does not recommend actions for a Business Transaction, but it does recommend actions for the underlying Application Components and infrastructure. The Pending Actions chart for a Business Transaction lists these actions, thus providing visibility into the risks that have a direct impact on the Business Transaction's performance.

Business Transaction Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

None

Turbonomic does not recommend actions for a Business Transaction, but it does recommend actions for the underlying Application Components and infrastructure. The Pending Actions chart for a Business Transaction lists these actions, thus providing visibility into the risks that have a direct impact on the Business Transaction's performance.

Transaction SLO

Enable this SLO if you are monitoring performance through your Business Transactions.

Attribute	Default Setting/Value
Enable Transaction SLO	Off Turbonomic estimates SLO based on monitored values.
Transaction SLO	None If you enable SLO, Turbonomic uses the default value of 10. You can change this to a different value.

Transaction SLO determines the upper limit for acceptable transactions per second. When the number of transactions reaches the given value, Turbonomic sets the risk index to 100%.

Response Time SLO

Enable this SLO if you are monitoring performance through your Business Transactions.

Attribute	Default Setting/Value
Enable Response Time SLO	Off Turbonomic estimates SLO based on monitored values.
Response Time SLO [ms]	None If you enable SLO, Turbonomic uses the default value of 2000. You can change this to a different value.

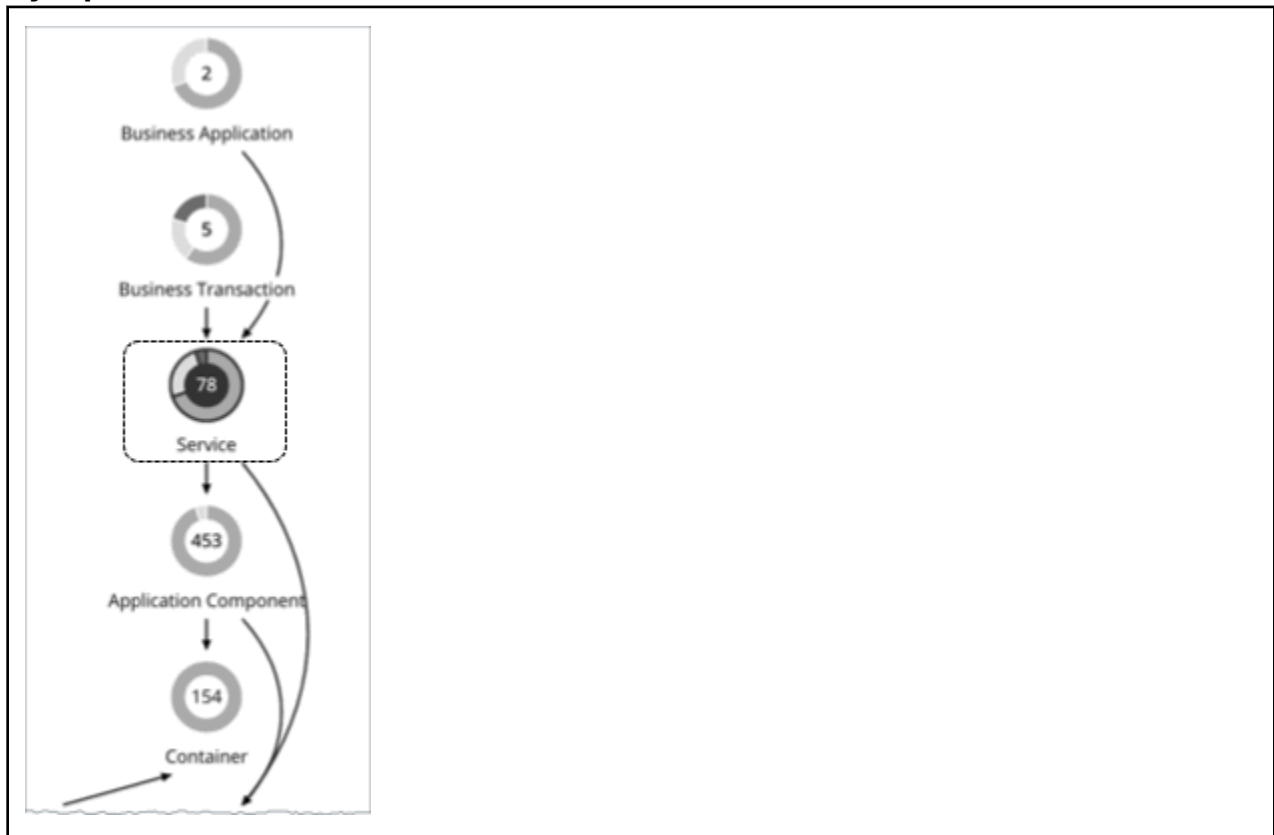
Response time SLO determines the upper limit for acceptable response time (in milliseconds). If response time reaches the given value, Turbonomic sets the risk index to 100%.

Service

A Service in the supply chain represents one or several Application Components that perform a defined, measurable function as part of an internal or user-initiated request. Its performance is key to understanding application performance, but only indirectly impacts user experience. You can measure performance as experienced internal to the Business Application in the context of Services.

For more information, see [Application Component](#) and [Business Application](#).

Synopsis



Synopsis	
Budget:	Services have unlimited budget.
Provides:	Response time and transactions to Business Transactions and Business Applications
Consumes from:	Application Components, Database Servers, and the underlying nodes
Discovery:	<p>For APM targets, Turbonomic discovers the following:</p> <ul style="list-style-type: none"> • AppDynamics Tiers • Dynatrace Services • Instana Services • NewRelic APM Applications / NewRelic Services (New Relic ONE) <p>Note:</p> <p>If you do not have an APM target, you can create your own Services using the Application Topology feature. For details, see Application Topology.</p> <p>For Kubernetes, Turbonomic discovers Kubernetes Services through the Kubeturbopod that you have deployed in your environment.</p>

Monitored Resources

Turbonomic monitors the following:

- Response Time

Response time (in milliseconds) for the given service

For Kubernetes, this is the desired *weighted average* response time of all Application Component replicas associated with a Service

- Transactions

Transactions per second for the given service

For Kubernetes, the maximum number of transactions per second that each Application Component replica can handle.

The **Response Time** and **Transaction** charts for a Service show average and peak/low values over time. You can gauge performance against the given SLOs. By default, Turbonomic estimates SLOs based on monitored values. You can set your own SLO values in policies.




Actions for non-Kubernetes Services

Turbonomic does not recommend actions for non-Kubernetes Services, but it does recommend actions for the underlying Application Components and nodes. The Pending Actions chart for Services lists these actions, thus providing visibility into the risks that have a direct impact on their performance.




Actions for Kubernetes Services

For horizontally scalable Kubernetes Services that collect performance metrics (or KPIs) for applications, Turbonomic can dynamically adjust the number of pod replicas that back those Services to help you meet SLOs (Service Level Objectives) for your applications.

For example, when current response time for an application is in direct violation of SLO, Turbonomic will recommend provisioning pods to improve response time. When you examine a pending action to provision pods, you will see *Response Time Congestion* as the reason for the action.

Provision Actions (16)				EXECUTE ACTIONS		
<input type="text" value="Type to search"/>				 ADD FILTER		
<div>Risk = Response Time Congestion X</div>						
<input type="checkbox"/> Container Pod Name	Container Cluster	Namespace	Risk			
<input type="checkbox"/> robot-shop/ratings-857bd6d9c4-5v	Kubernetes-endre-dc11	robot-shop	Response Time Congestion			
<input type="checkbox"/> robot-shop/ratings-857bd6d9c4-5v	Kubernetes-endre-dc11	robot-shop	Response Time Congestion			
<input type="checkbox"/> robot-shop/user-6ccb589cbd-4hbk	Kubernetes-endre-dc11	robot-shop	Response Time Congestion			

If applications can meet response time SLOs using less resources, Turbonomic will recommend suspending pods to improve infrastructure efficiency.

Suspend Actions (2)				EXECUTE ACTIONS		
<input type="text" value="Type to search"/>				 ADD FILTER		
<div>Risk = Improve infrastructure efficiency X</div>						
<input type="checkbox"/> Container Pod Name	Container Cluster	Namespace	Risk			
<input type="checkbox"/> demoapp/twitter-cass-api-5bd5898	Kubernetes-ccp-testbed	demoapp	Improve infrastructure efficiency			
<input type="checkbox"/> demoapp/twitter-cass-tweet-66588	Kubernetes-ccp-testbed	demoapp	Improve infrastructure efficiency			

Turbonomic generates these actions under the following conditions:

- Services are discovered by the KubeTurbo pod that you have deployed in your environment.
- Services collect performance metrics via [Instana](#) or [DIF](#).
- You have created [policies](#) for the Services.

Configure Service Policy

NAME
Policy_A

SCOPE

AH-Service_GP

ADD SERVICE GROUPS

POLICY SCHEDULE

AUTOMATION AND ORCHESTRATION

Defines how actions are accepted.

HORIZONTAL SCALE UP, HORIZONTAL SCALE DOWN

Action Acceptance: Manual

OPERATIONAL CONSTRAINTS

Response Time SLO [ms] 2000 ms

Enable Response Time SLO

Enable Transaction SLO

Transaction SLO 10

ADD CONSTRAINT

In those Service policies, be sure to:

- Turn on horizontal scaling (up and/or down).
- Enable Response Time and/or Transaction SLO, and then specify your desired SLO values.

- Response Time SLO

This is the desired *weighted average* response time of all Application Component replicas associated with a Service.

- Transaction SLO

This is the maximum number of transactions per second that each Application Component replica can handle.

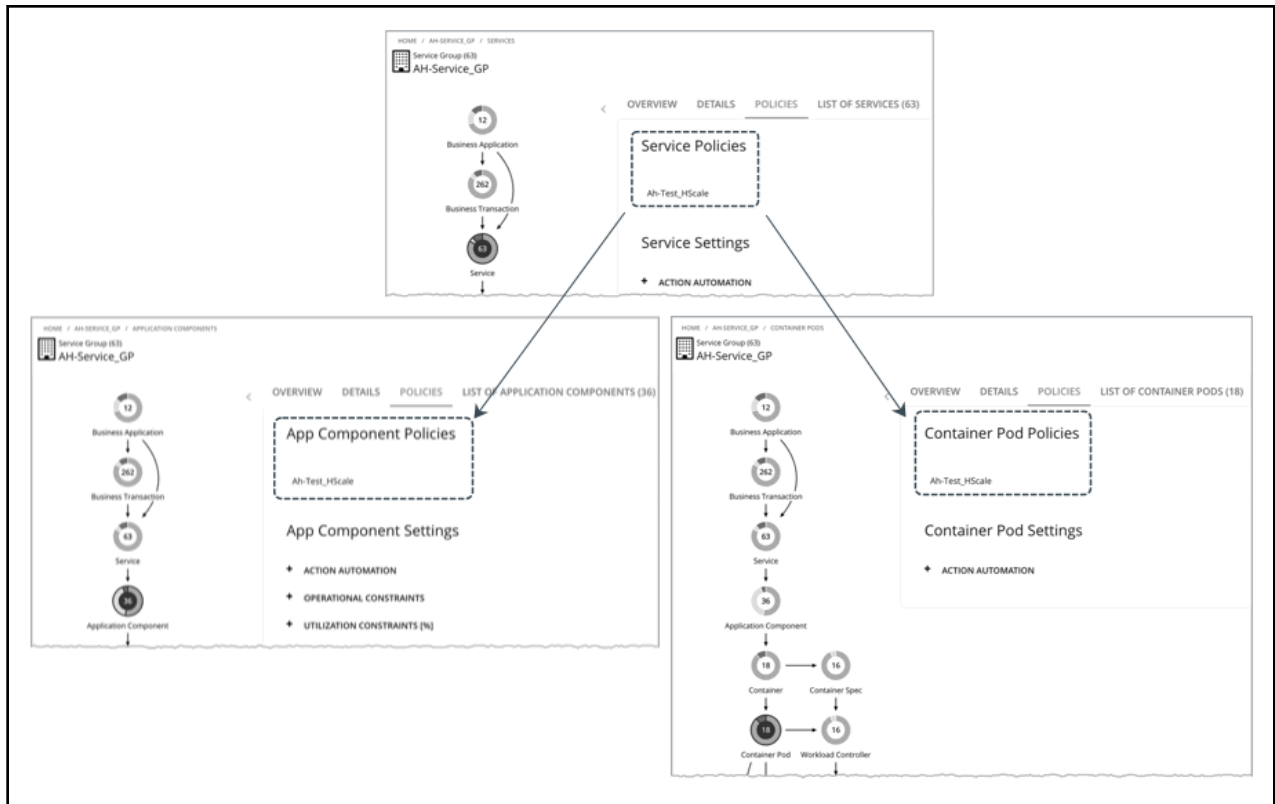
Note:

If you specified SLOs but turned off horizontal scaling in the policy, no actions are generated but SLO values will continue to display in the Response Time and Transaction charts for Services, for your reference. This allows you to gauge performance against those SLOs.

Propagation of Service Policy Settings

Settings in a Service policy propagate to the associated pods and Application Components to establish their relationship and provide context.

For example, assume you created a group of Services called AH-Service_GP and then applied the Service policy Ah-Test_HScale to that group. When you set the scope to this group, Ah-Test_HScale displays as a policy in the entity views for Services, Application Components, and Container Pods. You can click the policy name in any view to see or modify the policy settings.



To prevent conflicts, SLO values in Service policies override any SLOs set in Application Components. In addition, the Response Time and Transaction charts for Application Components show SLOs specified in the Service policy.

Action Automation Considerations

We recommend action automation under the following circumstances:

- Your applications run as a set of Kubernetes services backed by a deployment.
- Services deploy via a namespace *without* quotas.
- Newly provisioned pods are placed on nodes with the same CPU speed.
- You do not have an upstream Kubernetes HPA (Horizontal Pod Autoscaling) enabled for the same workload.

We recommend that you disable automation and manually execute actions under the following circumstances:

- Services deploy via a namespace *with* quotas.
- Newly created pods are scheduled on nodes with different CPU speeds.
- Services have non-resource constraints that could result in newly provisioned pods staying in the pending state.

Service Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For

example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Policies for Non-Kubernetes Services

• Action Automation and Orchestration

Turbonomic does not recommend actions for non-Kubernetes Services, but it does recommend actions for the underlying Application Components and nodes. The Pending Actions chart for Services list these actions, thus providing visibility into the risks that have a direct impact on their performance.

• Transaction SLO

Enable this SLO if you are monitoring performance through Services.

Attribute	Default Setting/Value
Enable Transaction SLO	Off Turbonomic estimates SLO based on monitored values.
Transaction SLO	None If you enable SLO, Turbonomic uses the default value of 10. You can change this to a different value.

Transaction SLO determines the upper limit for acceptable transactions per second. When the number of transactions reaches the given value, Turbonomic sets the risk index to 100%.

• Response Time SLO

Enable this SLO if you are monitoring performance through Services.

Attribute	Default Setting/Value
Enable Response Time SLO	Off Turbonomic estimates SLO based on monitored values.
Response Time SLO [ms]	None If you enable SLO, Turbonomic uses the default value of 2000. You can change this to a different value.

Response time SLO determines the upper limit for acceptable response time (in milliseconds). If response time reaches the given value, Turbonomic sets the risk index to 100%.

Policies for Kubernetes Services

• Action Automation and Orchestration

For horizontally scalable Kubernetes Services that collect performance metrics (or KPIs) for applications, Turbonomic can dynamically adjust the number of pod replicas that back those Services to help you meet SLOs (Service Level Objectives) for your applications.

To generate these actions, you must turn on horizontal scaling (up and/or down) and specify your desired SLOs in a Service policy.

For details about these actions and the environments that are suitable for automating these actions, see [Actions for Kubernetes Services](#).

Attribute	Default Setting/Value
Horizontal Scale Down	Off (Disabled)
Horizontal Scale Up	Off (Disabled)

- **Transaction SLO**

This is the maximum number of transactions per second that each Application Component replica can handle.

Attribute	Default Setting/Value
Enable Transaction SLO	Off
Transaction SLO	None If you enable SLO, Turbonomic uses the default value of 10. You can change this to a different value.

- **Response Time SLO**

This is the desired *weighted average* response time of all Application Component replicas associated with a Service.

Attribute	Default Setting/Value
Enable Response Time SLO	Off
Response Time SLO [ms]	None If you enable SLO, Turbonomic uses the default value of 2000. You can change this to a different value.

- **Minimum and Maximum Replicas**

You can adjust the default values based on the characteristics of your applications or if you are planning for capacity. The maximum value also acts as a safeguard against overprovisioning of replicas.

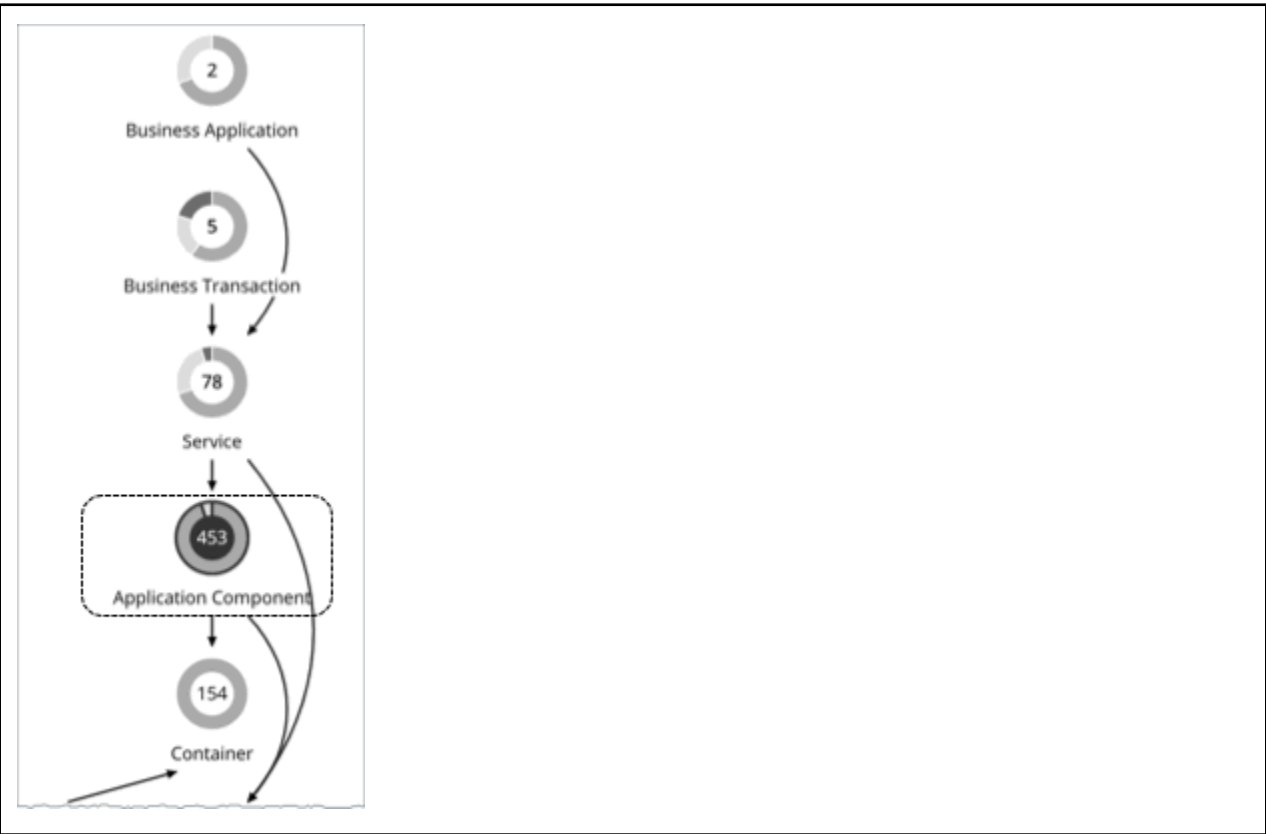
Attribute	Default Setting/Value
Minimum Replicas	1
Maximum Replicas	10000

Application Component

An Application Component is a software component, application code, or a unit of processing within a [Service](#) that consumes resources to enable it to perform its function for the [Business Application](#). For example, Apache Tomcat is a Java Servlet container that hosts a range of Java applications on the web.

Turbonomic can recommend actions to adjust the amount of resources available to Application Components.

Synopsis



Synopsis	
Budget:	Application Components have unlimited budget.
Provides:	<ul style="list-style-type: none">• Response Time and Transactions to Services, <u>Business Transactions</u>, and Business Applications• Response Time, Transactions, Heap, Remaining GC Capacity, and Threads to end users
Consumes:	Compute resources from nodes
Discovery:	<p>Turbonomic discovers the following:</p> <ul style="list-style-type: none">• Apache Tomcat• AppDynamics Nodes• Dynatrace Processes• NewRelic APM Application Instances• Application Insights Components• SNMP• WMI• Prometurbio or Data Ingestion Framework metrics for Kubernetes environments

Monitored Resources

The exact resources monitored will differ based on application type. This list includes all resources you may see.

- Virtual CPU (VCPU)

The utilization of the VCPU allocated to the hosting VM

Measured in Megahertz (MHz)

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

Measured in Kilobytes (KB)

- Transactions

Turbonomic discovers *key* transactions – transactions that the user marked as *key* to the application

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second

- Heap

The utilization of the application server's heap

Measured in Kilobytes (KB)

- Response Time

The utilization of the server's allocated response time

Measured in Milliseconds (ms)

- Connections

The utilization of the connection capacity. Only applicable to database servers

Measured in Connections

- Remaining Garbage Collection Capacity

The percentage of server uptime spent not performing garbage collection

Measured in uptime (%)

- Threads

The utilization of the server's thread capacity

Measured in number of Threads

The charts for an Application Component show average and peak/low values over time. You can gauge performance against the given SLOs. By default, Turbonomic does not enable SLOs in the default policy for Application Components. It estimates SLOs based on monitored values, but does not use these values in its analysis.

Note:

In Kubernetes environments, SLOs defined in a Service policy override any SLOs set in the associated Application Components to prevent conflicts. In addition, the Response Time and Transaction charts for Application Components will show SLOs specified in the Service policy. For more information, see [Actions for Kubernetes Services](#).

Actions

Resize

Resize the following resources to maintain performance:

- Thread Pool

- Connections
- Heap

Turbonomic will recommend Heap resize actions if the Application Component sells Heap and Remaining Garbage Collection (GC) Capacity, and the underlying VM or container sells VMem.

Note:

The resources that Turbonomic can resize depend on the processes that it discovers from your Applications and Databases targets. In the *Target Configuration Guide*, refer to the topic for a specific target to see a list of resources that can be resized.

Application Component Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about Application Component actions, see [Application Component Actions](#).

Action	Default Mode
Resize heap (up or down)	Recommend
Resize thread pool (up or down)	Recommend
Resize connections (up or down)	Recommend

You can use [Action Scripts](#) for action orchestration. Third-party orchestrators (such as ServiceNow) are not supported.

Transaction SLO

Enable this SLO to monitor the performance of your Application Components.

Note:

In Kubernetes environments, SLOs defined in a Service policy override any SLOs set in the associated Application Components to prevent conflicts. In addition, the Response Time and Transaction charts for Application Components will show SLOs specified in the Service policy. For more information, see [Actions for Kubernetes Services](#).

Attribute	Default Setting/Value
Enable Transaction SLO	Off Turbonomic estimates SLO based on monitored values.
Transaction SLO	None If you enable SLO, Turbonomic uses the default value of 10. You can change this to a different value.

Transaction SLO determines the upper limit for acceptable transactions per second. When the number of transactions reaches the given value, Turbonomic sets the risk index to 100%.

Response Time SLO

Enable this SLO to monitor the performance of your Application Components.

Note:

In Kubernetes environments, SLOs defined in a Service policy override any SLOs set in the associated Application Components to prevent conflicts. In addition, the Response Time and Transaction charts for Application Components will show SLOs specified in the Service policy. For more information, see [Actions for Kubernetes Services](#).

Attribute	Default Setting/Value
Enable Response Time SLO	Off Turbonomic estimates SLO based on monitored values.
Response Time SLO [ms]	None If you enable SLO, Turbonomic uses the default value of 2000. You can change this to a different value.

Response time SLO determines the upper limit for acceptable response time (in milliseconds). If response time reaches the given value, Turbonomic sets the risk index to 100%.

Heap Utilization

The Heap utilization that you set here specifies the percentage of the existing capacity that Turbonomic will consider to be 100% of capacity. For example, a value of 80 means that Turbonomic considers 80% utilization to be 100% of capacity.

Attribute	Default Value
Heap Utilization (%)	80

Turbonomic uses Heap utilization and Remaining GC Capacity (the percentage of CPU time *not* spent on garbage collection) when making scaling decisions. Assume Heap utilization is at 80%, which is 100% of capacity. However, if Remaining GC Capacity is at least 90% (in other words, CPU time spent on garbage collection is only 10% or less), an 80% Heap utilization does not indicate a shortage after all. As a result, Turbonomic will not recommend Heap scaling.

If Heap utilization is low and Remaining GC Capacity is high, Turbonomic will recommend resizing down Heap. If the opposite is true, then Turbonomic will recommend resizing up Heap.

Heap Scaling Increment

This increment specifies how many units to add or subtract when scaling Heap for an application component.

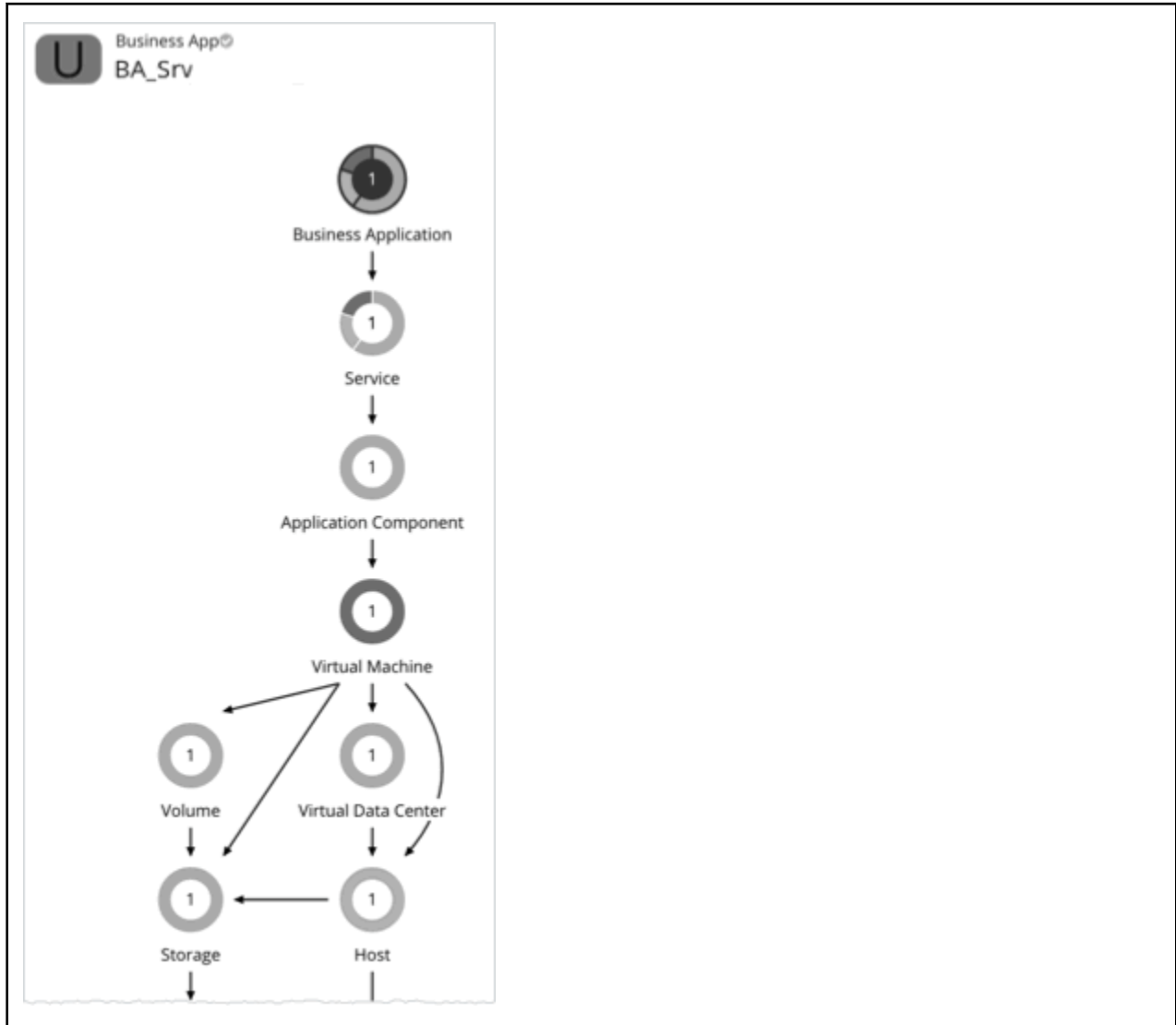
Attribute	Default Value
Heap Scaling Increment (MB)	128

Do not set the increment value to be lower than what is necessary for the Application Component to operate. If the increment is too low, then it's possible there would be insufficient Heap for the Application Component to operate. When reducing allocation, Turbonomic will not leave an Application Component with less than the increment value. For example, if you use the default 128, then Turbonomic cannot reduce the Heap to less than 128 MB.

Application Topology

Turbonomic gives you the ability to create your own [Business Applications](#), [Business Transactions](#), and [Services](#) without the need to ingest additional application data into the platform. This is especially useful in environments where there are gaps in the application stack shown in the Turbonomic supply chain. For example, in the absence of an application monitoring target such as AppDynamics or Dynatrace, you will not see Business Applications in your supply chain. User-created application entities address those gaps.

When you create a new application entity, you identify interrelated application entities and nodes in your existing environment for which you want to measure performance, so Turbonomic can link them in a supply chain and represent them as a unified group. You can monitor overall performance for the group in the context of the new application entity, and drill down to the individual entities and nodes for finer details.

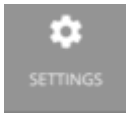


Turbonomic does not perform analysis on any user-created application entity, but it aggregates the underlying risks the same way it does for auto-discovered entities.

After you create an application entity, Turbonomic counts it in the global supply chain and adds it to the relevant charts (for example, if you created a new Service that has performance risks, you might see it listed in the Top Services chart). Drill down to the newly created entity to monitor its performance. You can also use Search to find the application entity and set it as your scope.

Creating Application Entities

1. Navigate to the **Settings** Page.



2. Choose **Application Topology**.



3. Click **New Application Topology** and then choose *Automatic* or *Manual*.

- Automatic

Create a new application entity composed of tagged entities. For example, create a new Business Application composed of VMs with the "Production" tag.

- Manual

Create a new application entity composed of a specific set of application entities and nodes.

4. Select the application entity type that you want to create.

5. If you chose *Automatic*:

Type an entity name prefix to help you easily identify the application entities that Turbonomic will create for you, and then specify the tags that will identify the underlying entities.

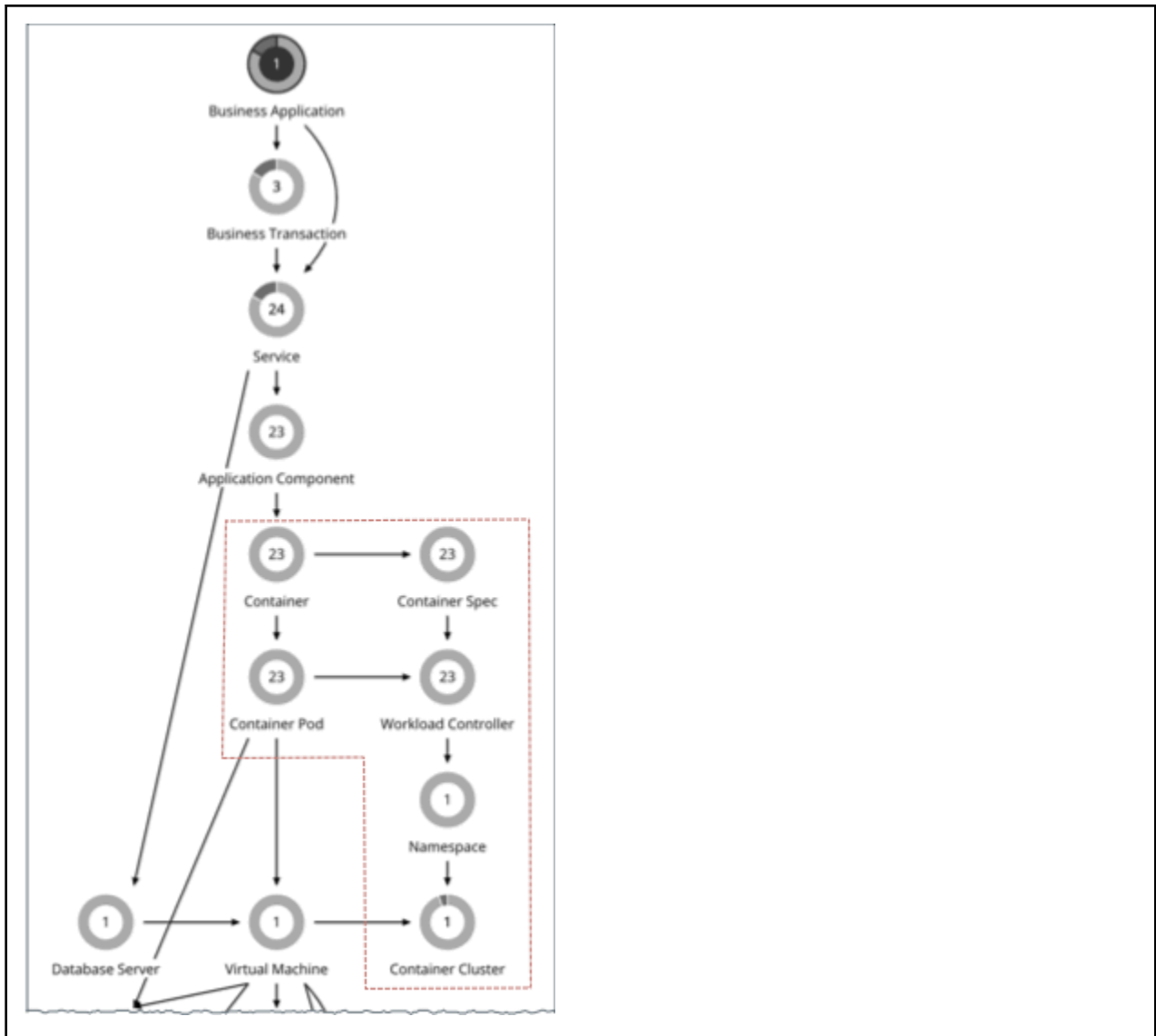
If you chose *Manual*:

Give the application entity a name and then add the underlying application entities and nodes.

6. Click **Create Definition**.

Entity Types - Container Platform

Turbonomic discovers and monitors the entities that make up your container platform, and recommends actions to assure performance for the applications that consume resources from these entities.



For a Cloud Native environment, Turbonomic discovers:

Entity Type	Kubernetes Object or Reference	Notes
Service	Service	A logical set of pods that represents a given application. In Kubernetes, the Service exposes a single entry point for the application process. While the Pods that comprise the service are ephemeral, the service is persistent. The Service entity also gives historical tracking of the number of replicas that run to support the Service.
Container	Container	The individual containers that deploy in your environment. Because the container instances that support a service can change at any time, these are considered <i>ephemeral</i> .
Container Pod	Pod	These are the smallest deployable units of computing that you can create and manage in Kubernetes. One Container Pod can contain multiple Container entities. These are also considered <i>ephemeral</i> .

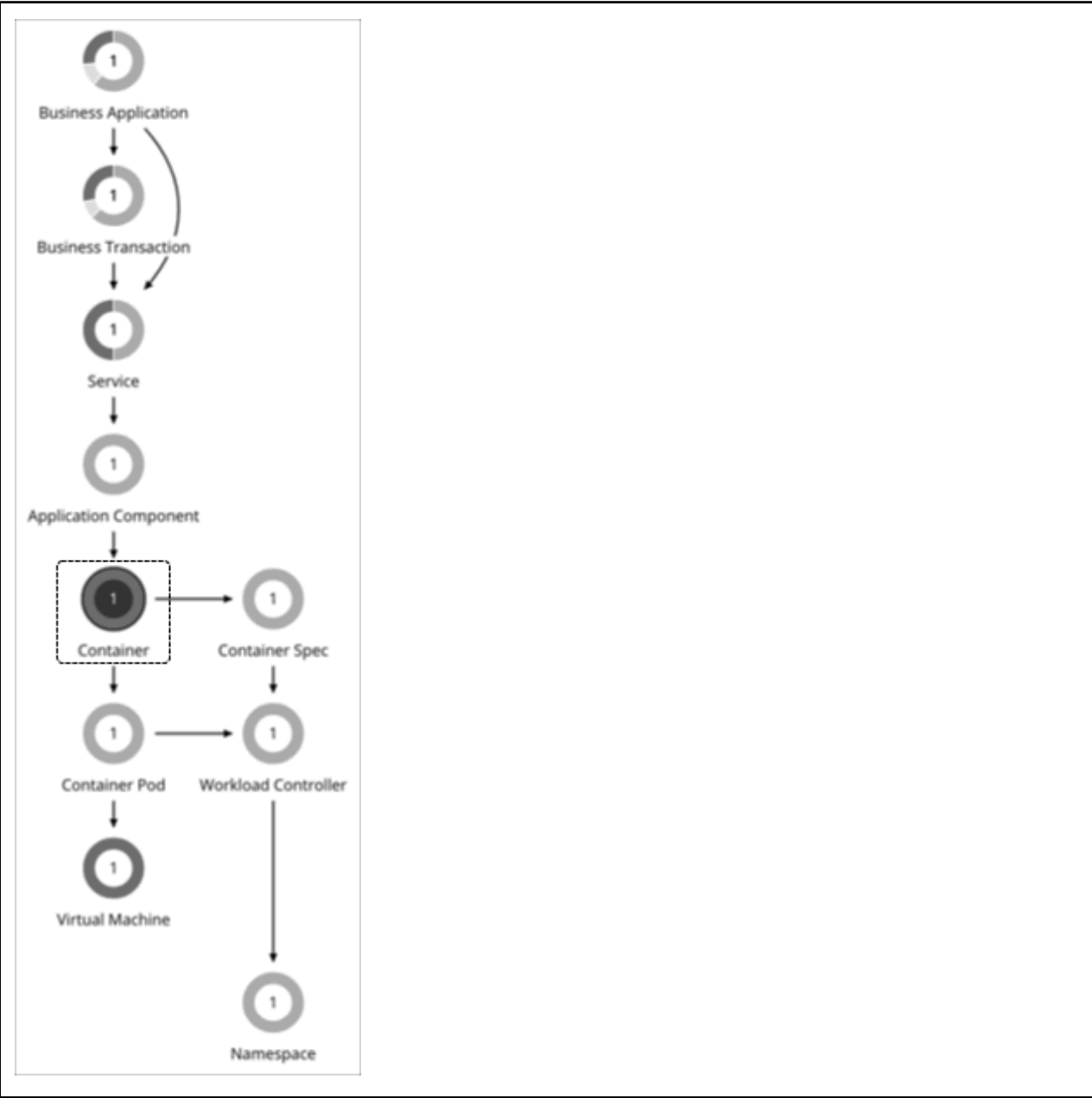
Entity Type	Kubernetes Object or Reference	Notes
Container Spec	A container's Spec	Persistent entities that collect containers with like properties. In Kubernetes the container's Spec includes the size specifications of limits and requests. In the Turbonomic supply chain, the count of replicas maps to the count of Container entities that a Container Spec encompasses. In Turbonomic, the persistent Container Spec maintains historical data for its ephemeral containers, and all the replicas that have run in the past.
Workload Controller	Controller	<p>A persistent entity that maps to the different controllers in your Kubernetes environment, such as Deployments or Stateful Sets. A single Workload Controller can contain one or more Container Spec entities, and it can be related to one or more running replica pods.</p> <p>In the Supply Chain, the Workload Controller exposes the impact of Namespace quotas on Container Spec resize actions. The Workload Controller aggregates resize actions for the containers that are in its supply chain. In this way, a single action on a Workload Controller can encompass multiple Container actions.</p>
Namespace	Namespace	<p>A logical group of workloads each namespace must be unique within a given Container Cluster. You can specify Resource Quotas for a Namespace, which limit compute resource capacity available to its workloads. Turbonomic will block execution of resize actions that would exceed Namespace quotas, and identify the quota increase you need to accommodate the workload resize.</p> <p>For OpenShift, a Namespace is equivalent to a Project.</p>
Container Cluster	Cluster	A collection of VMs (referred to as Nodes in Kubernetes). The Container Cluster scope aggregates actions so you can see cluster health in one view. This gives you an idea of cluster health from the perspective of your workloads.
Virtual Machine	Node	<p>The machines that provide compute resources to workloads. Turbonomic recommends actions on VMs to manage resources for the cluster. Actions to move pods horizontally scale workloads and nodes. Turbonomic recommends these actions to prevent node congestion, or to exploit opportunities to consolidate resources.</p> <p>Turbonomic can discover node roles and Master Nodes. It creates policies to keep nodes of the same role on unique host or Availability Zone providers, and policies to disable suspension of Master Nodes. Turbonomic also discovers and displays Node Pools, and OpenShift Machine Sets.</p>
Volume	PV	If a Container Pod is attached to a volume, Turbonomic discovers it as a Persistent Volume (PV), and shows which Pods are connected to the PV.

This section describes the Turbonomic entities that are unique to Cloud Native infrastructures. You can find descriptions of Service, Virtual Machine, and Volume entities in other sections of the User Guide.

Container

An application container is a standalone, executable image of software that includes components to host an application.

Synopsis



Synopsis	
Budget:	A container obtains its budget by selling resources to the hosted application.
Provides:	Resources for the applications to use: <ul style="list-style-type: none">• Virtual CPU• Virtual Memory
Consumes:	Resources from container pods, virtual machines, and virtual datacenters.

Synopsis

Discovered through:	<p>For Kubernetes, Turbonomic discovers containers through the Kubeturbo pod that you have deployed in your environment.</p> <p>For Dynatrace and AppDynamics hosted on containers:</p> <ul style="list-style-type: none">• Dynatrace: Turbonomic discovers containers through the metadata of processes.• AppDynamics: Turbonomic discovers containers through container objects.
---------------------	---

Monitored Resources

Turbonomic monitors the following resources for a container:

VMem

The virtual memory utilized by the container against the memory limit (if no limit is set, then node capacity is used). Measured in Megabytes (MB)

VMem Request

If applicable, the virtual memory utilized by the container against the memory request. Measured in Megabytes (MB)

VCPU

The virtual CPU utilized by the container against the CPU limit (if no limit is set, then node capacity is used). Measured in millicores (mCores)

VCPU Request

If applicable, the virtual CPU utilized by the container against the CPU request. Measured in millicores (mCores)

VCPU Throttling

The throttling of container vCPU that could impact response time, expressed as the percentage of throttling for all containers associated with a Container Spec. In the Capacity and Usage chart for containers, *used* and *utilization* values reflect the actual throttling percentage, while *capacity* value is always 100%.

Actions

Resize

Resize containers to assure optimal utilization of resources. By default, containers resize consistently, which allows all replicas of the same container for the same workload type to resize any resource consistently.

For vCPU limit resizes, Turbonomic will recommend a resize up action, even if utilization percentile is low, to address slow response times associated with vCPU throttling. Especially for sudden throttling spikes, it will persist the related resize actions so you can evaluate these actions even after the spikes have gone away, and then execute them to prevent spikes from re-occurring. As throttling drops, Turbonomic will not recommend a resize down action right away, as this could result in subsequent back-and-forth upsize and downsize recommendations. Instead, it evaluates past throttling to decide when a resize down action is finally safe to execute. To ensure the timeliness of these actions and arrive at the optimal resize values to recommend, Turbonomic calculates fast and slow moving throttling averages, and then displays smoothed and daily averages in charts.

Action Visibility, Merging, and Execution

Turbonomic shows and executes container resize actions via [Workload Controllers](#). You will *not* see actions when you set the scope to containers.

Actions also propagate to application entities and the underlying container infrastructure to show the impact of these actions on the health of your applications and container environment.

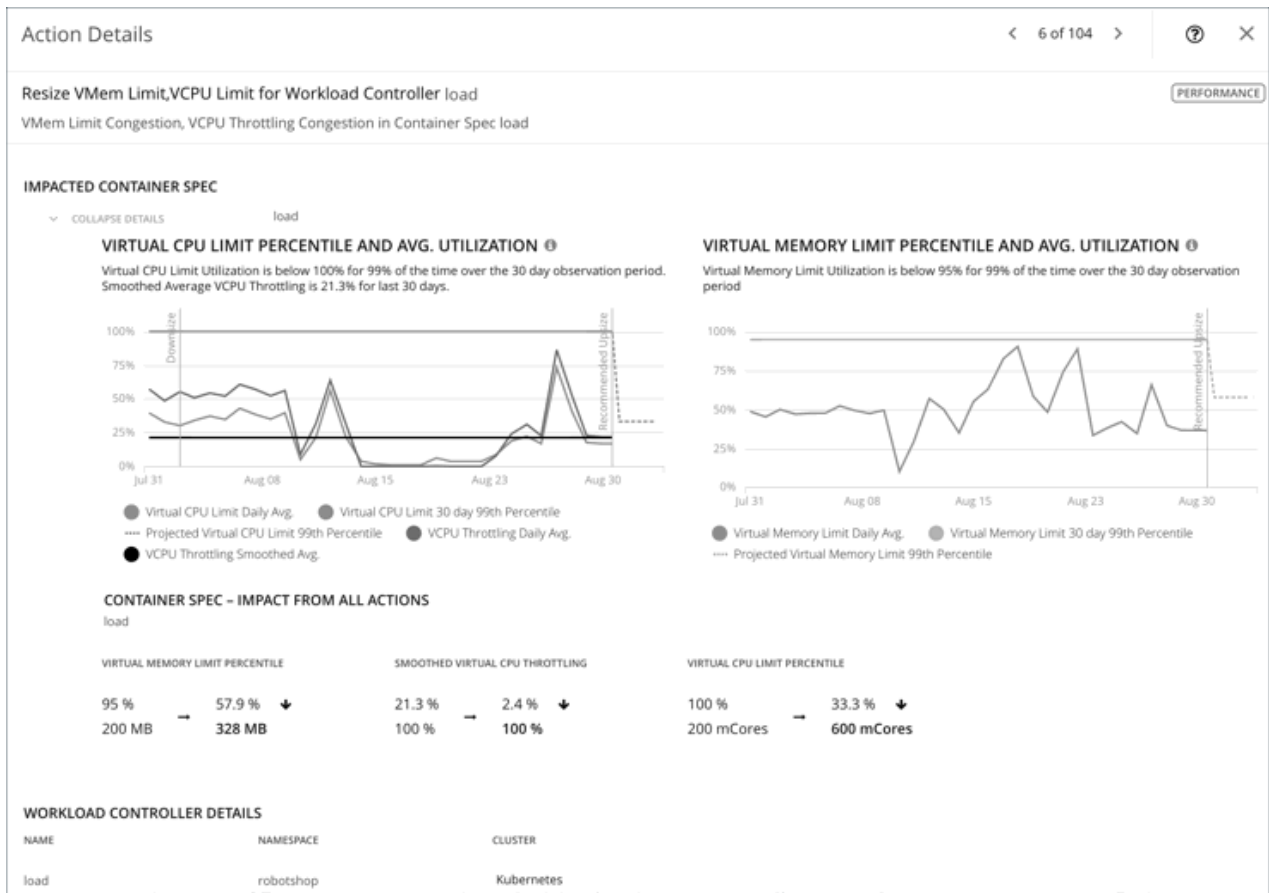
Executing several container resize actions can be very disruptive since pods need to restart with each resize. For replicas of the container scale group(s) related to a single Workload Controller, Turbonomic consolidates resize actions into one *merged action* to minimize disruptions. When a merged action has been executed (via the associated Workload Controller), all resizes for all related container specifications will be changed at the same time, and pods will restart once.

After you set the scope to Workload Controllers, go to the Pending Actions chart and then click **Show All** to see the full list of resize actions that you can execute. This list includes individual and merged actions. You can filter the list to focus on specific actions, such as actions to address resource congestion or vCPU throttling.

Action Description	Risk	Action Category	Action
<input type="checkbox"/> Resize VCPU Limit for Workload Controller (7-default-backend)	VCPU Throttling Congestion in Container Spe...	PERFORMANCE	DETAILS
<input type="checkbox"/> Resize VCPU Limit for Workload Controller addon-http-application-routing-default-http-backend	VCPU Throttling Congestion in Container Spe...	PERFORMANCE	DETAILS
<input type="checkbox"/> Resize VMem Limit,VCPU Limit for Workload Controller mysql	Underutilized VMem Limit, VCPU Throttling C...	PERFORMANCE	DETAILS
<input type="checkbox"/> Resize VCPU Request,VMem Limit,VCPU Limit for Workload Controller twitter-cassandra	Underutilized VCPU Request, Underutilized V...	PERFORMANCE	DETAILS
<input type="checkbox"/> Resize VMem Limit,VCPU Limit for Workload Controller rabbitmq	Underutilized VMem Limit, VCPU Throttling C...	PERFORMANCE	DETAILS
<input type="checkbox"/> Resize VMem Limit,VCPU Limit for Workload Controller load	VMem Limit Congestion, VCPU Throttling Con...	PERFORMANCE	DETAILS

By default, container resize actions are set in *Manual* mode at the Workload Controller level. This means that Turbonomic will not execute any action automatically, and you can manually select the actions that you want to execute. If you prefer to execute actions outside Turbonomic, create Workload Controller policies and set the resize action mode to *Recommend*. To automate actions, create Workload Controller policies and set the resize action mode to *Automatic*.

For each action, click DETAILS and expand the Details section to view time series charts that explain the reason for the action. These charts highlight *utilization percentiles* and *smoothed throttling averages* for a given observation period. Turbonomic uses percentile calculations to make accurate resize decisions.



These charts also:

- Plot daily average percentiles and throttling, for your reference.
- Show projected percentiles after you execute the action. If you have previously executed resize actions on the same Workload Controller, the charts show the resulting improvements in daily average utilization.

Put together, these charts allow you to easily recognize trends that drive Turbonomic's resize recommendations.

Note:

You can set scaling constraints in Container Spec policies to refine the percentile calculations. For details, see [Aggressiveness and Observation Periods](#).

Tuned Scaling for Containers

Turbonomic can automate resizes if the resize values fall within a normal range, and then post more conservative actions when resize values fall outside the range. To do this, you would set specific *action modes* and *tuned scaling* values in policies.

For example, consider resizing vMem limits. As memory demand increases, Turbonomic can automatically execute vMem limit resizes that fall within the normal range. If the Container Spec requests memory beyond the normal range, Turbonomic will either ignore the action or post it for you to review, depending on the tuned scaling settings that you configured.

Assume the following tuned scaling settings in policies:

- The **Operational Constraints** settings in the Container Spec policy specify 100 MB to 500 MB as the normal range.
- With the **Resize** action mode in the Workload Controller policy set to *Automatic*, Turbonomic will automate *resize up* actions that are below the *max* threshold and *resize down* actions that are above the *min* threshold.

Note:

If the action mode is *Recommend*, Turbonomic will post the actions for you to review. You can only execute these actions outside Turbonomic.

- In the Container Spec policy, since the action mode for **vMem Limit Resize Above Max** and **vMem Limit Resize Below Min** is set to *Disabled*, Turbonomic will not generate resize actions that fall outside the normal range.
- Since vMEM increment constant is *not* defined in the Container Spec policy, Turbonomic uses the default value of 128 MB.

With these two policies in effect:

- If a Container Spec with 200 MB of vMEM limit needs to resize to 328 MB, Turbonomic automatically resizes to 328 MB.
- If a Container Spec with 200 MB of vMEM limit needs to resize to 72 MB, Turbonomic does not generate the action. vMEM limit remains at 200 MB.

Note:

Action policies include scope to determine which entities will be affected by the given policy. It's possible for two or more policies to affect the same entities. As is true for other policy settings, Turbonomic uses the most conservative settings for the affected entities.

For tuned scaling, the effective action mode will be the most conservative, and the effective tuned scaling range will be the narrowest range (the lowest *Max* and highest *Min*) out of the multiple policies that affect the given entities. For more information, see [Policy Scope](#).

Container Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

Resize

Resize containers to assure optimal utilization of resources. By default, containers resize consistently, which allows all replicas of the same container for the same workload type to resize any resource consistently.

Turbonomic shows and executes container resize actions via [Workload Controllers](#). You will *not* see actions when you set the scope to containers.

Action	Default Mode	
	Container	Workload Controller
Resize	N/A	Manual (automatable)

For details, see [Container Actions](#).

Consistent Resizing

- *For groups in scoped policies:*

Attribute	Default Setting
Consistent Resizing	Off

When you create a policy for a group of containers and turn on Consistent Resizing, Turbonomic resizes all the group members to the same size, such that they all support the top utilization of each resource commodity in the group. For example, assume container A shows top utilization of CPU, and container B shows top utilization of memory. Container resize actions would result in all the containers with CPU capacity to satisfy container A, and memory capacity to satisfy container B.

For an affected resize, the Actions List shows individual resize actions for each of the containers in the group. If you automate resizes, Turbonomic executes each resize individually in a way that avoids disruption to your workloads.

- *For auto-discovered groups:*

Turbonomic discovers Kubernetes groups such as Deployments, ReplicationControllers, ReplicaSets, DaemonSets, and StatefulSets, and automatically enables Consistent Resizing in a read-only policy for each group. If you do not need to resize all the members consistently, create another policy for the group and turn off Consistent Resizing.

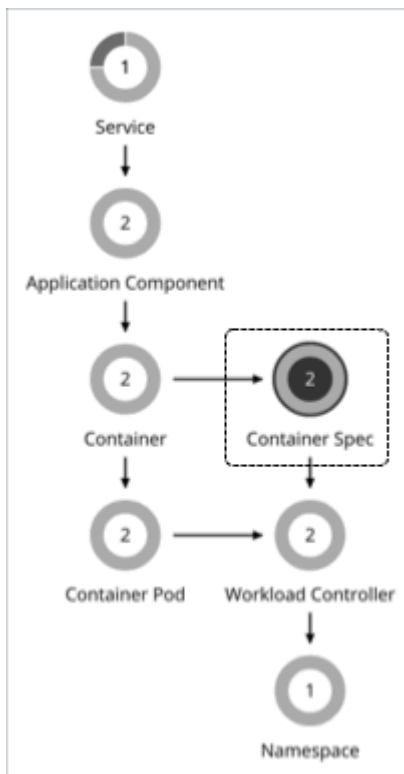
Container Spec

A Container Spec is a shared definition for all ephemeral container replicas. It is a persistent entity that retains the historical utilization data of containers, which Turbonomic leverages to make container sizing decisions. Utilization data includes:

- vCPU used by all container replicas

- vCPU request capacity (if applicable)
- vMem used by all container replicas
- vMem request capacity (if applicable)

Synopsis



Synopsis

Budget:	N/A
Provides:	N/A
Consumes:	N/A
Discovered through:	Kubeturbo Mediation Pod

Monitored Resources

When you view the resources for a Container Spec, you will see the historical usage of any instance of a container running for the workload (assuming the workload name stays the same). The chart shows the trend of usage even with restarts or redeployments.

Actions

None

A Container Spec retains the historical utilization data of ephemeral containers. Turbonomic uses this data to make accurate container resize decisions, but does not recommend actions for the Container Spec itself.

Note:

To view container resize actions, set the scope to the Workload Controller for related containers. Go to the Pending Actions chart and click **Show All** to see the full list. For more information about container actions, see [Container Actions](#).

Constraint for Sidecar Container Specs

A Kubernetes service might include [sidecar](#) Container Specs to provide additional services to a running pod, such as security or logging services. Sidecars injected at pod creation cannot be updated from the parent Workload Controller, causing a resize action to fail.

To prevent the execution of resize actions on injected sidecars, Turbonomic adds them to a group called "Injected Sidecars/All ContainerSpecs". This group applies a read-only policy that sets the action mode for resizes to *Recommend*. This means that you can only execute resizes outside of Turbonomic. The parent Workload Controller will continue to resize non-sidecar Container Specs as usual.

Container Spec Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

The following settings affect tuned scaling:

Setting	Default Mode
vCPU Request Resize Below Min	Recommend
vCPU Limit Resize Above Max	Recommend
vCPU Limit Resize Below Min	Recommend
vMem Request Resize Below Min	Recommend
vMem Limit Resize Above Max	Recommend
vMem Limit Resize Below Min	Recommend

The default mode of *Recommend* means that when resize values in actions fall outside the normal range (as defined in Container Spec policies), Turbonomic will post the actions for you to review. You can only execute these actions outside Turbonomic. If you set the action mode to *Disabled*, Turbonomic will not generate the actions.

For an overview of tuned scaling, see [Tuned Scaling for Containers](#).

Resize Thresholds

Turbonomic uses resize thresholds as operational constraints to set up tuned scaling for Container Specs. For an overview of tuned scaling, see [Tuned Scaling for Containers](#).

Attribute	Default Value
VCPU Request Resize Min Threshold (mCores)	10
VCPU Limit Resize Min Threshold (mCores)	500

Attribute	Default Value
VCPU Limit Resize Max Threshold (mCores)	64000
VMEM Request Resize Min Threshold (MB)	10
VMEM Resize Min Threshold (MB)	10
VMEM Resize Max Threshold (MB)	1048576

Increment Constants

Turbonomic recommends changes in terms of the specified resize increments.

Attribute	Default Value
Increment constant for VCPU Limit and VCPU Request (mCores)	100
Increment constant for VMEM Limit and VMEM Request (MB)	128

For example, assume the vCPU request increment is 100 mCores and you have requested 800 mCores for a container. Turbonomic could recommend to reduce the request by 100, down to 700 mCores.

For vMem, you should not set the increment value to be lower than what is necessary for the container to operate. If the vMem increment is too low, then it's possible that Turbonomic would allocate insufficient vMem. For a container that is underutilized, Turbonomic will reduce vMem allocation by the increment amount, but it will not leave a container with zero vMem. For example, if you set this to 128, then Turbonomic cannot reduce the vMem to less than 128 MB.

Rate of Resize

(For the *default* policy only)

Attribute	Default Value
Rate of Resize	High

When resizing resources for a container, Turbonomic calculates the optimal values for vMem and vCPU. But it does not necessarily make a change to that value in one action. Turbonomic uses the Rate of Resize setting to determine how to make the change in a single action, as follows:

- **Low**

Change the value by one increment, only. For example, if the resize action calls for increasing vMem, and the increment is set at 128, Turbonomic increases vMem by 128 MB.

- **Medium**

Change the value by an increment that is 1/4 of the difference between the current value and the optimal value. For example, if the current vMem is 2 GB and the optimal vMem is 10 GB, then Turbonomic will raise vMem to 4 GB (or as close to that as the increment constant will allow).

- **High**

Change the value to be the optimal value. For example, if the current vMem is 2 GB and the optimal vMem is 8 GB, then Turbonomic will raise vMem to 8 GB (or as close to that as the increment constant will allow).

Aggressiveness and Observation Periods

Turbonomic uses these settings to calculate utilization percentiles for vCPU and vMEM. It then recommends actions to improve utilization based on the observed values for a given time period.

• Aggressiveness

Attribute	Default Value
Aggressiveness	99th Percentile

When evaluating vCPU and vMEM performance, Turbonomic considers resource utilization as a percentage of capacity. The utilization drives actions to scale the available capacity either up or down. To measure utilization, the analysis considers a given utilization percentile. For example, assume a 99th percentile. The percentile utilization is the highest value that 99% of the observed samples fall below. Compare that to average utilization, which is the average of *all* the observed samples.

Using a percentile, Turbonomic can recommend more relevant actions. This is important in the cloud, so that analysis can better exploit the elasticity of the cloud. For scheduled policies, the more relevant actions will tend to remain viable when their execution is put off to a later time.

For example, consider decisions to reduce the capacity for CPU on a container. Without using a percentile, Turbonomic never resizes below the recognized peak utilization. For most containers there are moments when peak CPU reaches high levels. Assume utilization for a container peaked at 100% just once. Without the benefit of a percentile, Turbonomic will not reduce allocated CPU for that container.

With **Aggressiveness**, instead of using the single highest utilization value, Turbonomic uses the percentile you set. For the above example, assume a single CPU burst to 100%, but for 99% of the samples CPU never exceeded 50%. If you set **Aggressiveness** to 99th Percentile, then Turbonomic can see this as an opportunity to reduce CPU allocation for the container.

In summary, a percentile evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, as follows:

- 100th Percentile – The least aggressive, recommended for critical workloads that need maximum guaranteed performance at all times.
- 99th Percentile (Default) – The recommended setting to achieve maximum performance and savings.
- 90th Percentile – Most aggressive, recommended for non-production workloads that can stand higher resource utilization.

• Max Observation Period

Attribute	Default Value
Max Observation Period	Last 30 Days

To refine the calculation of resource utilization percentiles, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. (If the database has fewer days' data then it uses all of the stored historical data.)

A shorter period means there are fewer data points to account for when Turbonomic calculates utilization percentiles. This results in more dynamic, elastic resizing, while a longer period results in more stable or less elastic resizing. You can make the following settings:

- Less Elastic – Last 90 Days
- Recommended – Last 30 Days
- More Elastic – Last 7 Days

• Min Observation Period

Attribute	Default Value
Min Observation Period	1 Day

This setting ensures historical data for a minimum number of days before Turbonomic will generate an action based on the percentile set in **Aggressiveness**. This ensures a minimum set of data points before it generates the action.

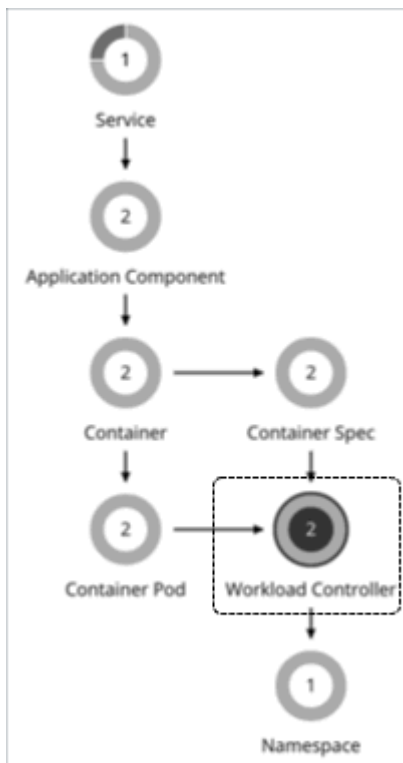
Especially for scheduled actions, it is important that resize calculations use enough historical data to generate actions that will remain viable even during a scheduled maintenance window. A maintenance window is usually set for "down" time, when utilization is low. If analysis uses enough historical data for an action, then the action is more likely to remain viable during the maintenance window.

- More Elastic – None
- Recommended – 1 Day
- Less Elastic – 3 or 7 Days

Workload Controller

A Workload Controller is a Kubernetes controller that watches the state of your pods and then requests changes where needed. You can execute container resize actions when you set the scope to a Workload Controller.

Synopsis



Synopsis

Budget:	N/A
Provides:	N/A

Synopsis

Consumes:	N/A
Discovered through:	Kubeturbo Mediation Pod

Monitored Resources

Turbonomic does not monitor resources for Workload Controllers.

Actions

None

A Workload Controller executes container actions. When you set the scope to a Workload Controller and view the actions list, the actions apply to containers. Turbonomic does not recommend actions for the Workload Controller itself.

Note:

Turbonomic uses namespace or organization/space quotas as constraints when making resize decisions. The Workload Controller aggregates container actions. If those container resizes exceed current namespace quotas, Turbonomic blocks execution of container resize actions until the namespace quotas are sufficient. For more information about namespace quotas, see [Resource Quotas](#).

For resize actions on a Workload Controller, the actions details include descriptions of the affected Container Spec entities, and how the resources will change for each. If the resize exceeds current namespace quotas, then Turbonomic blocks the Workload Controller action. The action details list the Namespace actions that block execution of this resize in the **Related Actions** list.

Action Details

Resize VCPU Limit, VMem Limit for Workload Controller [cpu-quota-3](#)

VCPU Throttling Congestion, VMem Limit Congestion in Container Spec [cpu-quota-3-spec](#)

IMPACTED CONTAINER SPEC

▼ [COLLAPSE DETAILS](#)

[cpu-quota-3-spec](#)

STATE

Action execution is blocked by related actions.

RELATED ACTIONS

BLOCKED BY

Resize up VCPU Limit Quota for Namespace [quota-test-with-down](#) from 3,200 mCores to 3,600 mCores in EA - Advanced Engineering
Resize up VMem Limit Quota for Namespace [quota-test-with-down](#) from 3.4 GB to 4 GB in EA - Advanced Engineering

For more information about container actions, see [Container Actions](#).

Workload Controller Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

Turbonomic shows and executes container resize actions via [Workload Controllers](#). You will *not* see actions when you set the scope to containers.

Action	Default Mode	
	Container	Workload Controller
Resize	N/A	Manual (automatable)

For details, see [Container Actions](#).

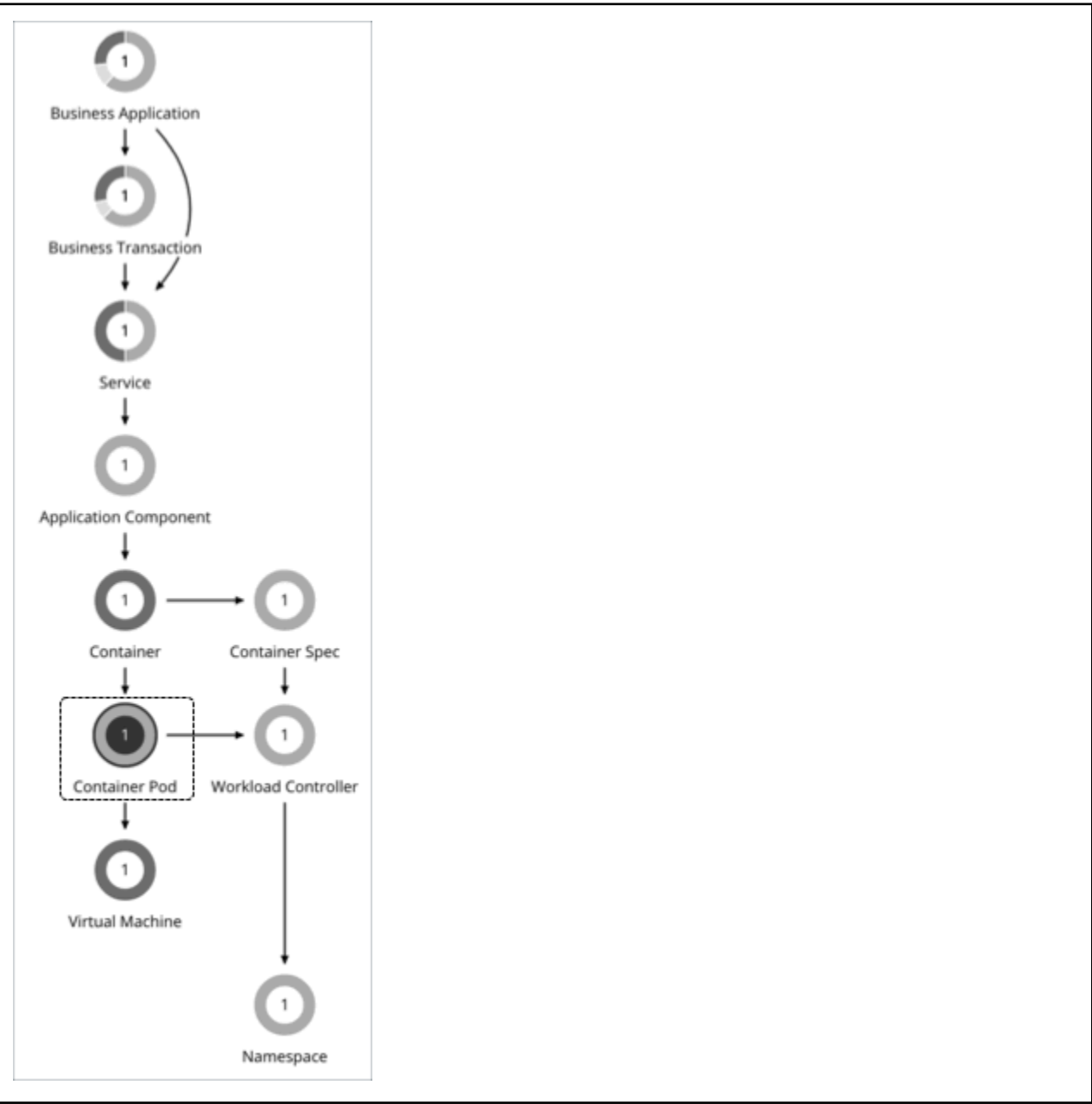
Executing several container resize actions can be very disruptive since pods need to restart with each resize. For replicas of the container scale group(s) related to a single Workload Controller, Turbonomic consolidates resize actions into one *merged action* to minimize disruptions. When a merged action has been executed (via the associated Workload Controller), all resizes for all related container specifications will be changed at the same time, and pods will restart once.

Action orchestration is currently not supported.

Container Pod

A ContainerPod is a Kubernetes pod, which is a group of one or more containers with shared storage or network resources and a specification for how to run the containers together.

Synopsis



Synopsis	
Budget:	A container pod obtains its budget by selling resources to containers.
Provides:	Resources for containers to use: <ul style="list-style-type: none">• Virtual CPU• Virtual Memory
Consumes:	Resources from virtual machines and namespaces.
Discovered through:	Turbonomic discovers Kubernetes pods through the Kubeturbo pod that you have deployed in your environment.

Monitored Resources

Turbonomic monitors the following resources for a container pod:

VMem

The virtual memory utilized by the pod against the node physical capacity. Measured in Megabytes (MB)

VCPU

The virtual CPU utilized by the pod against the node physical capacity. Measured in millicores (mCores)

VMem Request

The virtual memory request allocated by the pod against the node allocatable capacity. Measured in Megabytes (MB)

VCPU Request

The virtual CPU request allocated by the pod against the node allocatable capacity. Measured in millicores (mCores)

VMem Request Quota

If applicable, The amount of virtual memory request the pod has allocated against the namespace quota. Measured in Megabytes (MB)

VCPU Request Quota

If applicable, The amount of virtual CPU request the pod has allocated against the namespace quota. Measured in millicores (mCores)

VMem Limit Quota

If applicable, The amount of virtual memory limit the pod has allocated against the namespace quota. Measured in Megabytes (MB)

VCPU Limit Quota

If applicable, The amount of virtual CPU limit the pod has allocated against the namespace quota. Measured in millicores (mCores)

Move Actions

Move a pod between nodes (VMs) to address performance issues or improve infrastructure efficiency. For example, if a particular node is congested for CPU, you can move pods to a node with sufficient capacity. If a node is underutilized and is a candidate for suspension, you must first move the pods before you can safely suspend the node.

The following items affect the *Move* actions that Turbonomic recommends for pods:

- Constraints

Turbonomic respects the following constraints when making placement decisions for pods:

- Kubernetes taints for nodes and tolerations for pods are treated as constraints. For example, if a pod has a toleration attribute that restricts it from moving to a certain node, Turbonomic will not move that pod to the restricted node.
- Turbonomic imports Kubernetes node labels and treats them as constraints. For example, if a pod has a defined node label, Turbonomic will move that pod to a node with a matching label.
- Turbonomic recognizes pod affinity and anti-affinity policies.
- You can create placement policies to enforce constraints for pod move actions. For example, you can have a policy that allows pods to only move to certain nodes, or a policy that prevents pods from moving to certain nodes.

For more information, see [Creating Placement Policies](#).

- Eviction Thresholds

Turbonomic considers the memory/storage eviction thresholds of the destination node to ensure that the pod can be scheduled after it moves. Eviction thresholds for `imagefs` and `rootfs` are reflected as node effective capacity in the market analysis.

- Temporary Quota Increases

If a namespace quota is already fully utilized, Turbonomic temporarily increases the quota to allow a pod to move, while maintaining that one replica continues to run. You can disable temporary increases in quotas, but be aware that this will result in failure to move pods. To disable increases, set the following in the yaml resource for Kubeturbo deployment:

```
update-quota-to-allow-moves=false
```

Provision and Suspend Actions

Turbonomic can recommend provisioning or suspending pods under the following conditions:

- For horizontally scalable Kubernetes Services that collect performance metrics (or KPIs) for applications, Turbonomic can dynamically adjust the number of pod replicas that back those Services to help you meet SLOs (Service Level Objectives) for your applications.

For details, see [Actions for Kubernetes Services](#).

- When recommending node provision actions, Turbonomic also recommends pod provision actions that reflect the projected demand from required DaemonSet pods, and respects the maximum number of pods allowed for a node. This ensures that any application workload can be placed on the new node and stay within the desired range of vMem/vCPU usage, vMem/vCPU request, and number of consumers.

The action details for a pod provision action shows the related node that you need to provision. Click the node name to set it at your scope.

Action Details < 1 of 25 > ? X

Provision Container Pod similar to kube-system/nodelocaldns-2pcw6 PERFORMANCE
Clone kube-system/nodelocaldns-2pcw6 on cloned node1

CONTAINER POD DETAILS

NAME	WORKLOAD CONTROLLER	NAMESPACE	CONTAINER CLUSTER
nodelocaldns-2p...	nodelocaldns	kube-system	Kubernetes-Turb...

TAGS

controller-revision-hash: 599484f7f4 pod-template-generation: 1 k8s-app: nodelocaldns

CURRENT CONTAINER POD - IMPACT FROM ALL ACTIONS

kube-system/nodelocaldns-2pcw6

No Impact

STATE

Action acceptance is blocked by policy or system.
Acceptance mode is Recommend.

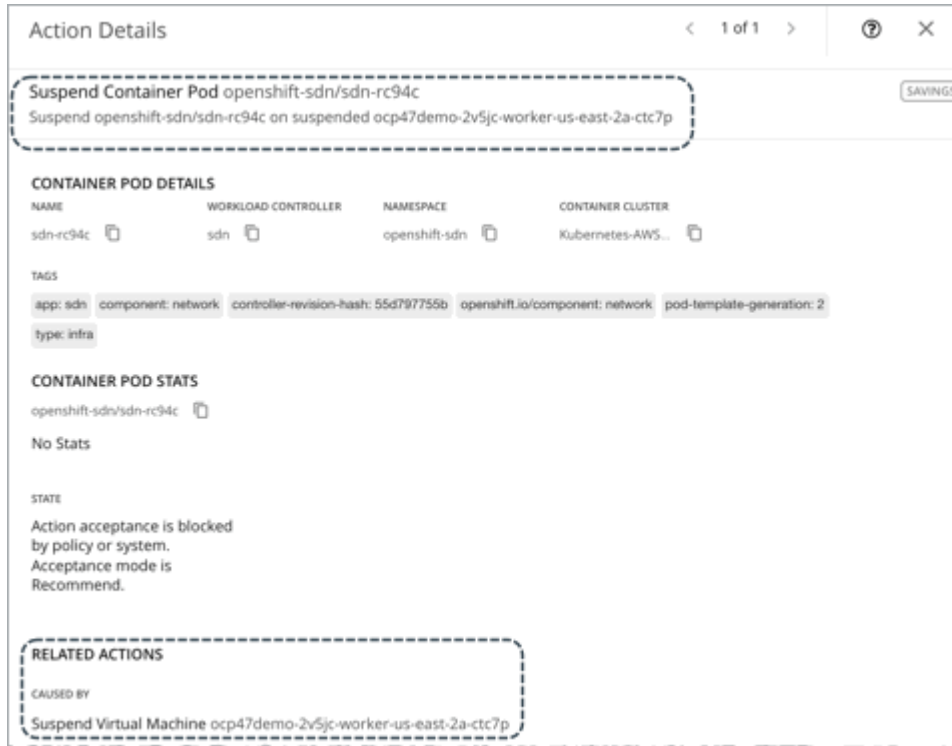
RELATED ACTIONS

CAUSED BY

Provision Virtual Machine similar to node1

- When recommending node suspension actions, Turbonomic also recommends suspending the DaemonSet pods that are no longer required to run the suspended nodes.

The action details for a pod suspension action shows the related node that you need to suspend. Click the node name to set it at your scope.



Container Pod Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about container pod actions, see [Container Pod Actions](#).

Action	Default Mode
Move	Manual

Action orchestration is currently not supported.

Placement Policies

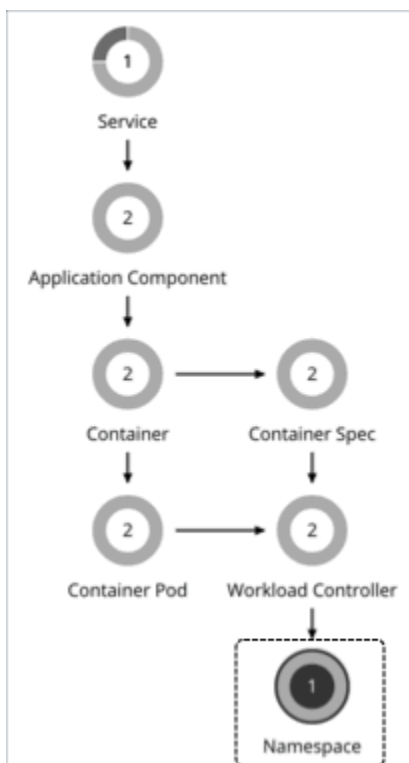
You can create placement policies to enforce constraints for pod move actions. For example, you can have a policy that allows pods to only move to certain nodes, or a policy that prevents pods from moving to certain nodes.

For more information, see [Creating Placement Policies](#).

Namespace

A namespace is a logical pool of resources in a Kubernetes environment that manages workloads based on specific requirements or business needs. For example, administrators can pool resources for different organizations within the enterprise, and assign different policies to each pool.

Synopsis



Synopsis

Budget:	N/A
Provides:	N/A
Consumes:	N/A
Discovered through:	Kubeturbo Mediation Pod

Resource Quotas

A namespace can include the following compute resource quotas:

VMem Request Quota

The total amount of virtual memory request for all pods allocated to the namespace against the namespace quota. Measured in Megabytes (MB)

VCPU Request Quota

The total amount of virtual CPU request for all pods allocated to the namespace against the namespace quota. Measured in millicores (mCores)

VMem Limit Quota

The total amount of virtual memory limit for all pods allocated to the namespace against the namespace quota. Measured in Megabytes (MB)

VCPU Limit Quota

The total amount of virtual CPU limit for all pods allocated to the namespace against the namespace quota. Measured in millicores (mCores)

When they are configured, these quotas define the capacity for the given namespace. Turbonomic recognizes these quotas as it calculates actions in your environment.

If containers in the namespace require more compute resources, and those requirements exceed the namespace quotas, then Turbonomic recommends increasing the quotas. It will *block* execution of the underlying container actions until the namespace quotas are sufficient. In the details for a quota resize action, you can see the list of blocked container actions.

For more about actions to increase namespace quotas, see [Actions](#).

When you run Optimize Container Cluster plans, Turbonomic can calculate increased namespace quotas in the plan results. For more information, see [Optimize Container Cluster Plan](#).

Turbonomic treats quotas defined in namespaces as constraints when making sizing decisions for containers. When you scope to a namespace in the supply chain, the Capacity and Usage chart shows *Capacity* as the namespace quotas. *Used* values are the sum of resource limits and/or requests set for all pods in the namespace.

Capacity and Usage ? ⋮			
nsquota			
COMMODITY	CAPACITY	USED	UTILIZATION
Memory Request Quota ⓘ	640 MB	640 MB	100%
CPU Limit Quota ⓘ	500 mCores	500 mCores	100%
Memory Limit Quota ⓘ	1.25 GB	1.25 GB	100%
CPU Request Quota ⓘ	250 mCores	100 mCores	40%
Virtual Memory Request	90.99 GB	640 MB	0.69%
SHOW ALL >			

For a namespace that does not have defined quotas, *Capacity* for the commodity is infinite (as shown in the image below). *Used* values are the sum of resource limits and/or requests set for all pods in the namespace. If these are not set, *Used* value is 0 (zero).

Capacity and Usage ? ⋮			
openshift-sdn			
COMMODITY	CAPACITY	USED	UTILIZATION
Memory Request Quota ⓘ	∞	4.99 GB	0%
CPU Request Quota ⓘ	∞	1.03 Cores	0%
Memory Limit Quota ⓘ	∞	0 KB	0%
CPU Limit Quota ⓘ	∞	0 mCores	0%
Virtual Memory Request	192.04 GB	4.99 GB	2.6%
SHOW ALL >			

Note:

If you download the data in the chart, the downloaded file shows infinite capacities as unusually large values (for example, 1,000,000,000 cores instead of the ∞ symbol).

Labels and Annotations

Turbonomic discovers namespace labels and annotations as tag properties. You can filter namespaces by labels or annotations when you use Search or create Groups.

Monitored Resources

Turbonomic monitors actual utilization of VMem, VCPU, VMem Requests and VCPU Requests against cluster capacity.

You can see utilization data in the **Capacity and Usage** and **Namespace Multiple Resources** charts. With this data, you can understand how pods running in the namespace are consuming resources.

To see which namespaces use the most cluster resources, set the scope to a container cluster and see the **Top Namespaces** chart. You can use the data in the chart for showback analysis.

Actions**Resize Quota**

Turbonomic treats quotas defined in a namespace as constraints when making container resize decisions. If existing container actions would exceed the namespace quotas, Turbonomic recommends actions to resize up the affected namespace quota.

Note that Turbonomic does not recommend actions to resize *down* a namespace quota. Such an action reduces the capacity that is already allocated to an application – The decision to resize down a namespace quota should include the application owner.

Turbonomic only recommends a resize for namespace quotas if underlying actions to resize containers require the increased quota. Note that Turbonomic aggregates container actions in Workload Controller entities. When you have a recommendation to resize namespace quotas, Turbonomic blocks execution of the resize actions for the affected Workload Containers. The action details show these blocked actions in the **Related Actions** list.

Action Details

Resize up VMem Limit Quota for Namespace [quota-test-with-down](#) from 3.4 GB to 4 GB
VMem Limit Congestion in Related Workload Controller

TAGS

`kubernetes.io/metadata.name: quota-test-with-down`

NAMESPACE - IMPACT FROM ALL ACTIONS

[quota-test-with-down](#)

MEMORY LIMIT QUOTA		CPU LIMIT QUOTA	
100 %	→ 84.8 % ↓	100 %	→ 88.9 % ↓
3.4 GB	→ 4 GB	3.2 Cores	→ 3.6 Cores

STATE

Action acceptance is blocked by policy or system.
Acceptance mode is Recommend.

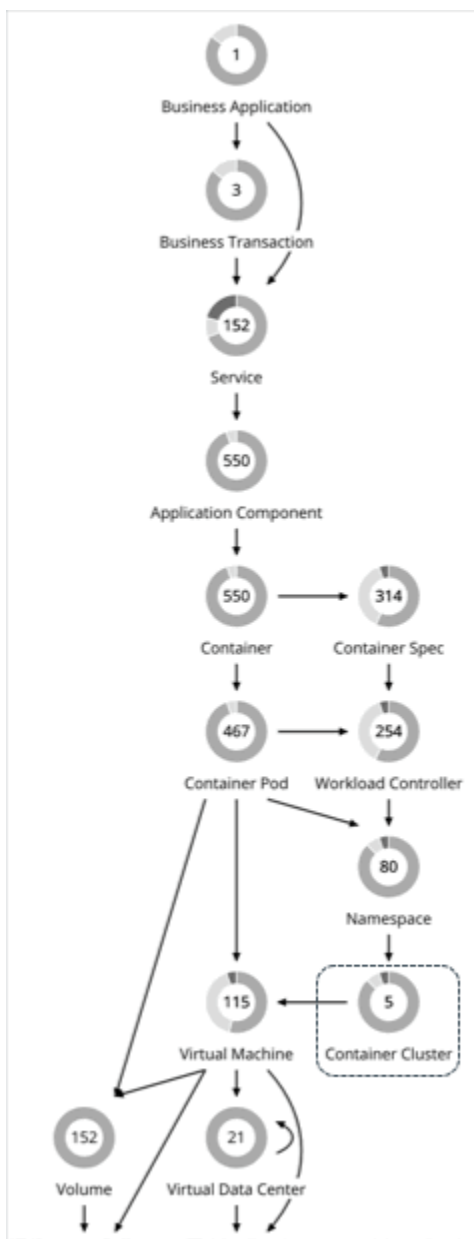
RELATED ACTIONS

BLOCKING

- Resize VCPU Limit, VMem Limit for Workload Controller [cpu-quota-3](#) in EA - Advanced Engineering
- Resize VCPU Limit, VMem Limit for Workload Controller [cpu-quota-1](#) in EA - Advanced Engineering

Container Cluster

Synopsis



Synopsis

Budget:	N/A
Provides:	N/A
Consumes:	N/A
Discovered through:	Kubeturbo Mediation Pod

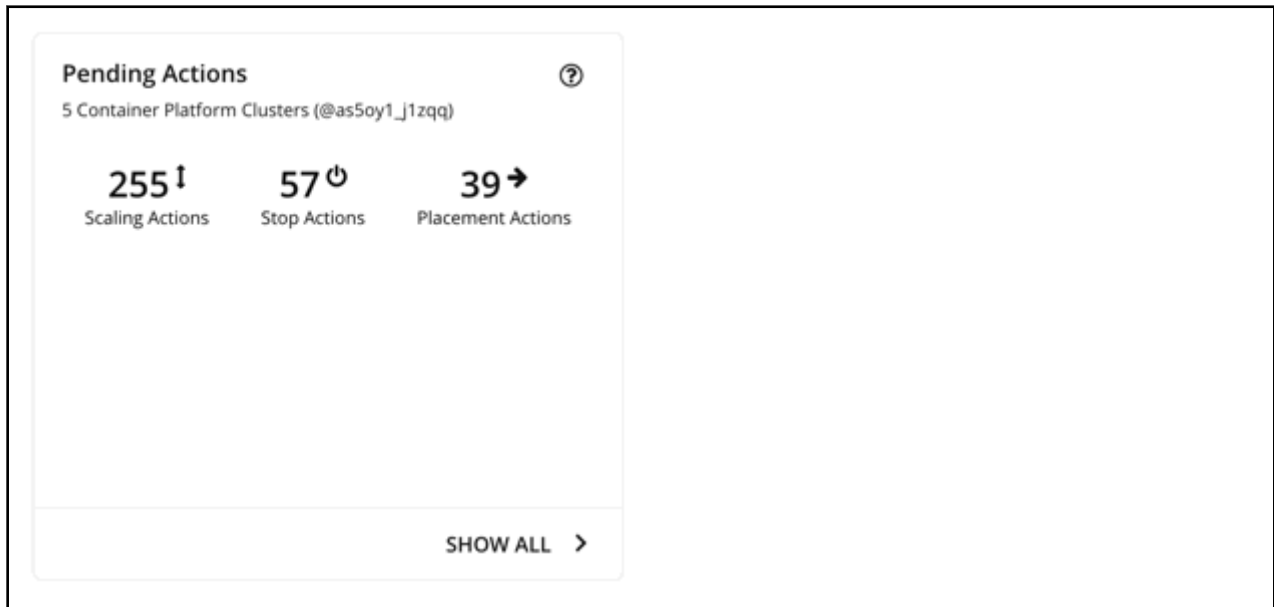
Monitored Resources

Turbonomic does not monitor resources for Kubernetes clusters. Instead, it monitors resources for the containers, pods, nodes (VMs), and volumes in the cluster.

Actions

None

Turbonomic does not recommend actions for a Container Cluster. Instead, it recommends actions for the containers, pods, nodes (VMs), and volumes in the cluster. Turbonomic shows all of these actions when you scope to a Container Cluster and view the Pending Actions chart.



For actions on nodes:

- For actions to suspend or provision nodes in the public cloud, Turbonomic includes cost information (investments or savings) attached to those actions. Note that Turbonomic generates these actions *not* to optimize costs, but to assure performance and efficiency for your container infrastructure. Turbonomic reports costs to help you track your cloud spend.

To view cost information, set the scope to a cluster in the public cloud and view the Necessary Investments or Potential Savings charts. You can also set the scope to the global cloud environment to see total costs, or to individual container clusters or nodes.

- For VMs/nodes that make up an Azure Kubernetes Service (AKS) cluster, you can manually execute recommended VM Provision and VM Suspend actions. This adjusts the count of nodes in a given node pool, where Provision raises the node count, and Suspend lowers it. You can execute these actions if the cluster is also discovered through an Azure target (along with the KubeTurbo target).
- Node pools and machine sets are ways to deploy and scale compute resources for Kubernetes services hosted in the public cloud and the OpenShift 4.x container platform on any infrastructure.

For Kubernetes services in the public cloud, Turbonomic uses default labels with the following patterns to discover the node pool types within each cluster:

- Azure Kubernetes Service (AKS): `agentpool`
- Amazon Elastic Kubernetes Service (EKS):
`//alpha.eksctl.io/nodegroup-name`
`eks.amazonaws.com/nodegroup`
- Google Kubernetes Engine (GKE): `cloud.google.com/gke-nodepool`

For OpenShift 4.x, Turbonomic creates node pools based on machine sets.

For both discovered and auto-created node pools, Turbonomic aggregates and visualizes actions for all the nodes in a pool to help you identify performance issues and optimization opportunities at the node pool level. Use the Top Node Pools chart to see actions and detailed information. By default, this chart

displays when you set the scope to your global environment and then click the Container Cluster entity in the supply chain.

Top Node Pools
Global Environment

SORT BY: POTENTIAL SAVINGS ↓

Name	Node Count	Potential Savings ⓘ	Potential Investments ⓘ	Actions
NodePool-machineset-ocp47demo-2v5jc-worker-us-	6	\$165.11/mo	\$165.11/mo	26 ACTIONS
NodePool-eks-cluster-ng2-Kubernetes-EKS-withWin	2	\$8.69/mo	N/A	1 ACTION
NodePool-agentpool-Kubernetes-AKS	4	\$0.00/mo	N/A	no actions
NodePool-ami-005fb2dc84caa293d-Kubernetes-EK!	2	\$0.00/mo	N/A	no actions
NodePool-ami-0a99721a12001ebd4-Kubernetes-EK	2	\$0.00/mo	N/A	no actions
NodePool-bar-Kubernetes-DC11-PT-K8s	1	\$0.00/mo	N/A	no actions
NodePool-eks-cluster-ng1-Kubernetes-EKS-withWin	1	\$0.00/mo	N/A	no actions

SHOW ALL >

The chart shows the number of nodes and aggregated actions for each node pool. For node pools in the public cloud, the chart also shows the costs you would incur if you provision nodes and then scale their volumes, or the savings you would realize if you suspend nodes. To view individual actions, click the button under the Actions column. To see more details, including the full list of nodes for each pool, click the node pool name.

You can automate the execution of these actions through Turbonomic with OpenShift 4.x Machine Operator, or via an Action Script. You can also manually execute node actions for AKS, EKS, or GKE via the cloud provider.

Note:

The following capabilities will be introduced in a future release:

- Actions to provision or suspend nodes via a plan simulation
- Policies for node pools
- Execution of node actions for AKS, EKS and GKE through Turbonomic

Cluster Health

To assess the health of each cluster, see the **Top Container Platform Clusters** chart in the predefined Container Platform Dashboard.

For each cluster, the chart shows the sum of resources used by containers and the underlying nodes. Click the **Actions** button to see a list of pending actions.

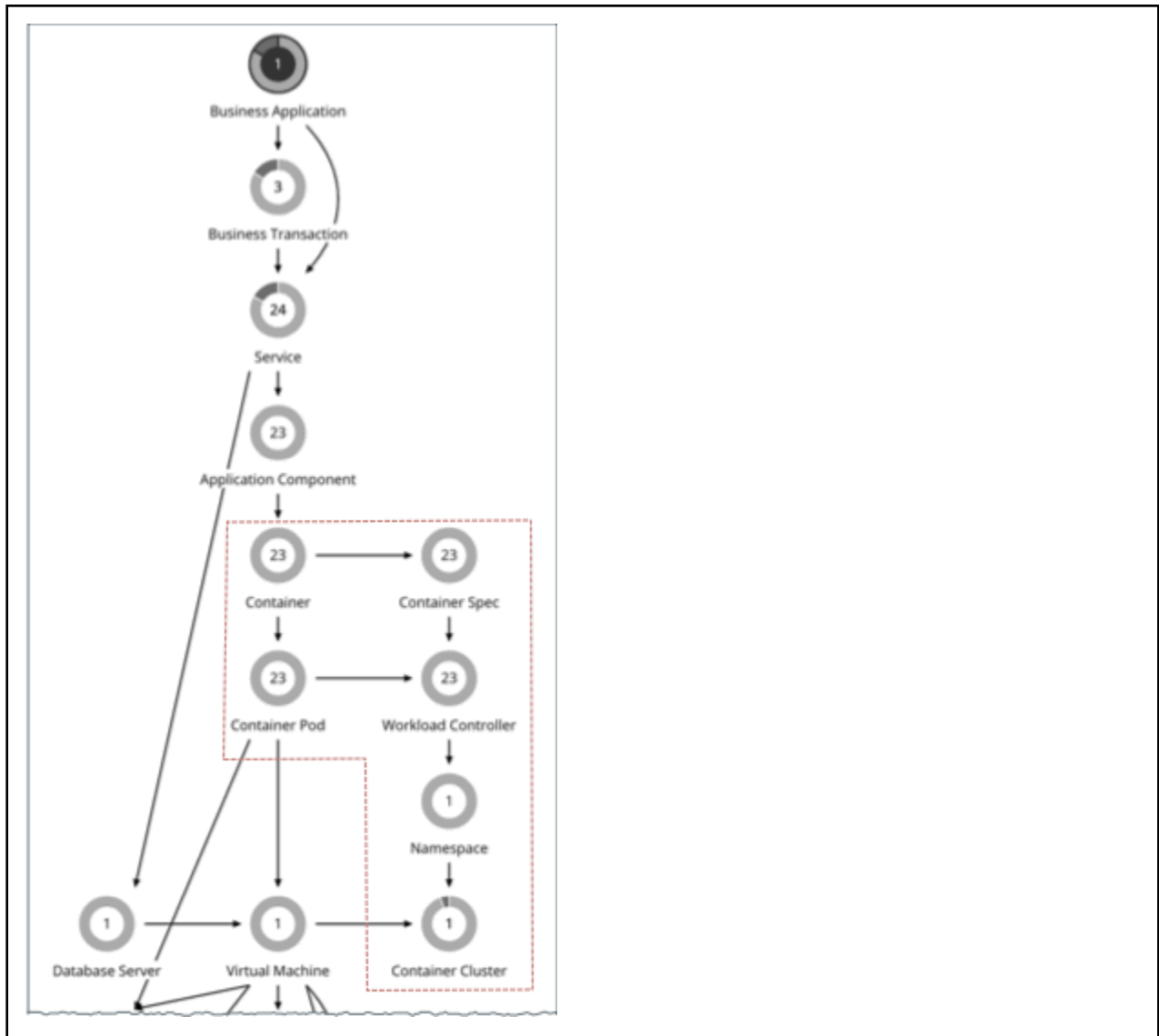
Top Container Platform Clusters							?	:
Global Environment								
							SORT BY: HEALTH ↓	
Container Cluster	Health	Virtual CPU Used	Virtual CPU Request	Virtual Memory Used	Virtual Memory Request	Actions		
Kubernetes-PT-AKS	<div><div></div></div>	8.2 Cores (41%) ↓ 0.31%	13.01 Cores (68%)	20.58 GB (28%) ↓ 0%	21.66 GB (40%)	60 ACTIONS		
Kubernetes-DC11-PT-KBs	<div><div></div></div>	6.78 Cores (28%) ↓ 3%	11.46 Cores (50%)	24.67 GB (26%) ↑ 0.1%	12.27 GB (13%)	139 ACTIONS		
Kubernetes-OCP47-AWS	<div><div></div></div>	13.36 Cores (26%) ↑ 2%	12.87 Cores (27%) ↑ 3%	90.84 GB (45%) ↓ 13%	72.4 GB (38%) ↑ 0.69%	217 ACTIONS		
Kubernetes-OKD-311	<div><div></div></div>	4.07 Cores (16%) ↓ 9%	8.86 Cores (35%) ↑ 1%	27.94 GB (30%) ↑ 23%	21.35 GB (23%) ↑ 0.92%	119 ACTIONS		
Kubernetes-ocp-wdc02	<div><div></div></div>	10.02 Cores (21%) ↓ 17%	10.6 Cores (22%) ↓ 0.92%	208.77 GB (55%) ↓ 24%	103.17 GB (30%) ↑ 2%	319 ACTIONS		
Kubernetes-OCP43-AWS	<div><div></div></div>	3.32 Cores (21%) ↑ 17%	7.41 Cores (51%) ↓ 0%	23.72 GB (38%) ↑ 2%	15.53 GB (26%) ↓ 0%	16 ACTIONS		
Kubernetes-Turbonomic	<div><div></div></div>	5.11 Cores (64%) ↑ 27%	0.95 Cores (12%)	61.83 GB (49%) ↑ 5%	18.03 GB (14%)	73 ACTIONS		
							SHOW ALL >	

The **Top Namespaces** chart shows the namespaces that use the most cluster resources. You can use the data in the chart for showback analysis.

Top Namespaces									?	:
Global Environment										
									SORT BY: HEALTH ↓	
Namespace	H.	Container Cluster	Virtual CPU Used	CPU Request Quota	CPU Limit Quota	Virtual Memory Used	Memory Request Quota	Memory Limit Quota	Actions	
demoapp		OKD-311	152 mCores (1%) ↓ 0.19%	100 mCores (0%)	200 mCores (0%)	1.91 MB (0%)	10 MB (0%)	20 MB (0%)	72 ACTIONS	
action-merge-test		OKD-311	16 mCores (0%) ↓ 5%	100 mCores (0%)	200 mCores (0%)	153.23 MB (0%) ↑ 0.08%	260 MB (0%)	400 MB (0%)	75 ACTIONS	
action-merge-test2		OKD-311	202 mCores (1%) ↓ 0.07%	90 mCores (0%)	202 mCores (0%)	2.2 MB (0%) ↑ 4%	260 MB (0%)	400 MB (0%)	78 ACTIONS	
turbo-operator-arsen		OCP47-AWS	92 mCores (0%) ↑ 279%	200 mCores (0%)	1 Cores (0%)	202.93 MB (0%) ↑ 6%	512 MB (0%)	1 GB (0%)	5 ACTIONS	
provelt		DC11-PT-KBs	442 mCores (2%) ↓ 0.09%	606 mCores (15%)	5.78 Cores (72%)	585.42 MB (1%)	2.44 GB (24%)	20.88 GB (42%)	84 ACTIONS	
instana-agent		OCP47-AWS	1.27 Cores (2%) ↑ 1%	2.5 Cores (0%)	7.5 Cores (0%)	2.58 GB (1%) ↓ 4%	2.5 GB (0%)	2.5 GB (0%)	17 ACTIONS	
aqiql-cpu-throttling		DC11-PT-KBs	757 mCores (3%) ↑ 0.18%	600 mCores (0%)	1.35 Cores (0%)	23.71 MB (0%)	50 MB (0%)	100 MB (0%)	78 ACTIONS	
									SHOW ALL >	

Kubernetes CPU Metrics

To meet user requirements and align with Kubernetes specifications, Turbonomic uses millicore (mCore) as the base unit for CPU metrics for your Kubernetes platform.



These include metrics for the following CPU-related commodities:

- vCPU
- vCPU Request
- vCPU Limit Quota
- vCPU Request Quota

Turbonomic displays these commodities in charts, actions, policies, and plans. For example:

- In the Capacity and Usage chart for container platform entities, *capacity* and *used* values for CPU-related commodities are shown in mCores.
- In the supply chain, when you scope to a Workload Controller to view pending resize actions for a container, you will see utilization and resize values in mCores.
- When you create Container Spec policies, resize thresholds and increment constants for CPU-related commodities are set in mCores.
- For an Optimize Container Cluster plan, the plan results for CPU-related commodities are shown in mCores.

For nodes (VMs) and Application Components:

- For nodes stitched to your Kubernetes platform, the base unit for *vCPU Request* is also mCore, since this commodity is provided only to Kubernetes.

- For both nodes and Application Components (standalone or stitched to your Kubernetes platform), the base unit for vCPU is MHz, since this is a generic commodity. For example, when you view a pod move action, vCPU metrics for the current and destination nodes for the pod are expressed in MHz.

The following table summarizes the base units of CPU measurement that Turbonomic uses.

Entity	CPU Commodity			
	vCPU	vCPU Request	vCPU Limit Quota	vCPU Request Quota
Container	mCore	mCore	mCore	mCore
Container Spec	mCore	mCore	N/A	N/A
Workload Controller	N/A	N/A	mCore	mCore
Container Pod	mCore	mCore	mCore	mCore
Namespace	mCore	mCore	mCore	mCore
Container Cluster	mCore	mCore	N/A	N/A
Node (VM)	MHz	mCore	N/A	N/A
Application Component	MHz	N/A	N/A	N/A

This feature is available starting in version 8.2.5. For customers updating to version 8.2.5 or later:

- This feature does *not* require you to update your Kubeturbo image after the update.
- For time series charts, metrics generated *after* the update are actual mCore values, but pre-update metrics are the same (unconverted) values in MHz displayed in mCore units. This results in unexpected data in charts immediately after the update.

For example:

If vCPU Limit for a Container Spec was resized from 1300 MHz to 1200 MHz *before* you updated Turbonomic, data points in charts correctly show these values in MHz.

Immediately after the update:

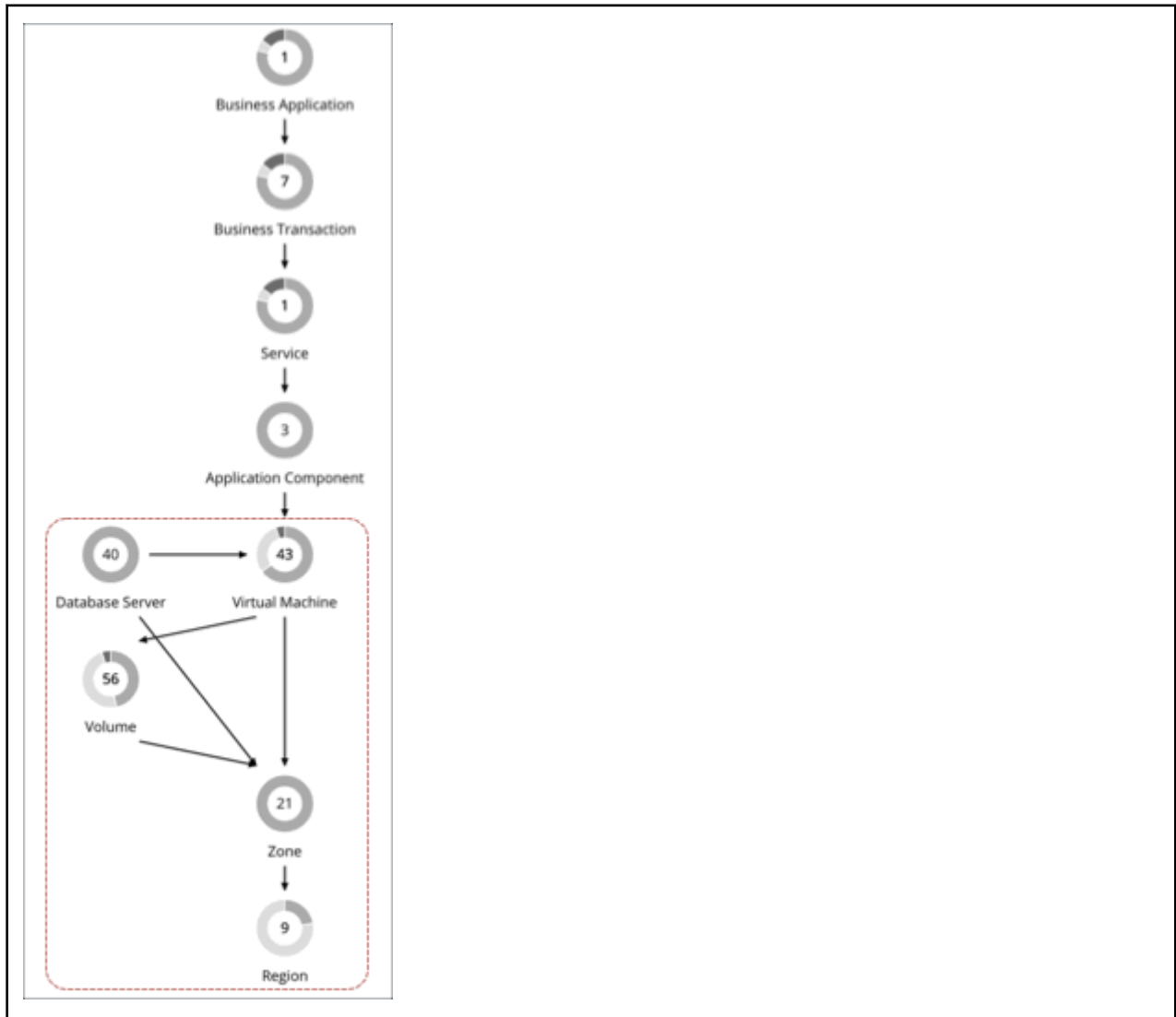
- When you view the Virtual CPU chart for the Container Spec, Turbonomic will show a capacity value of 1200 mCores (which is 1200 MHz in reality) for the last data point *before* the update, and the equivalent value of 500 mCores for the first data point *after* the update. This gives the impression of a resize down action between the data points, even if no such action was executed.
- Assume Turbonomic recommends an action to resize VCPU Limit for the Container Spec from 500 to 700 mCores. When you view the details for this action via the associated Workload Controller, the time series chart will show unexpected data.
 - For the actual recommended action, the data point shows current capacity as 1200 mCores, instead of 500 mCores. The new value after executing the action correctly shows as 700 mCores.
 - For the last resize action before the update, the data point shows the same MHz values (1300 and 1200), but in mCore units.
 - One day after the update, a new data point displays in the chart, indicating that capacity was resized from 1200 mCores to 500 mCores, even if no actual resize action was executed.

Over time, data points with unexpected values will begin to fall out of range and newer data points will reflect actual mCore values.

- For increment constants in Container Spec policies, the default value of 100 remains unchanged, but the unit changes from MHz to mCores. This means that each resize action will now increase or decrease capacity by 100 mCores, instead of 100 MHz.

Entity Types - Cloud Infrastructure

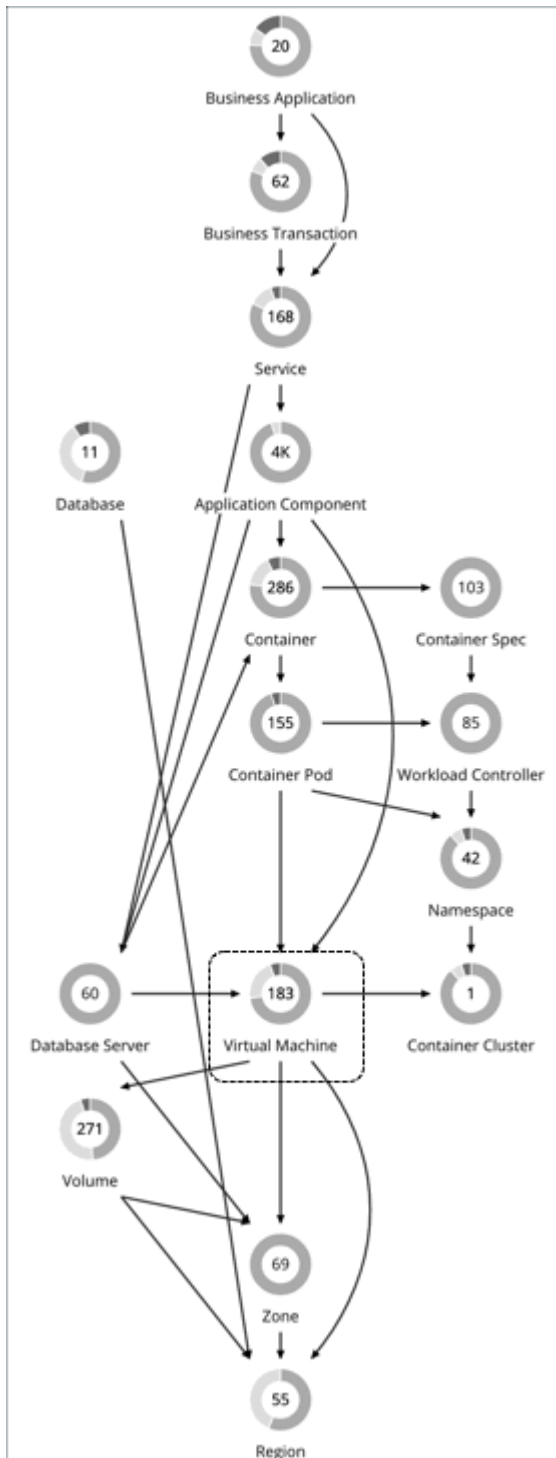
Turbonomic discovers and monitors the entities that make up your cloud infrastructure, and recommends actions to assure application performance at the lowest possible cost.



Virtual Machine (Cloud)

A virtual machine (VM) is a software emulation of a physical machine, including OS, virtual memory and CPUs, and network ports. VMs host applications, or they provide resources to container platforms.

Synopsis



Synopsis

Budget:

A VM gains its budget by selling resources to the applications it hosts.

Synopsis

Provides:	Resources for hosted applications to use: <ul style="list-style-type: none">• VMEM (Kbytes)• VCPU (MHz)• VStorage• IOPS (storage access operations per second)• Latency (capacity for disk latency in ms)• Memory and CPU Requests (for Kubernetes environments)
Consumes:	Resources from cloud zones
Discovered through:	Cloud targets

Monitored Resources

Turbonomic monitors the following resources for a cloud VM:

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
Measured in Kilobytes (KB)
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
Measured in Megahertz (MHz)
- Storage Amount
The utilization of the datastore's capacity
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
Measured in IOPS
- Net Throughput
Rate of message delivery over a port
Measured in KB/s
- Net Throughput Inbound
Rate of message received over a port
Measured in KB/s
- Net Throughput Outbound
Rate of message sent over a port
Measured in KB/s
- I/O Throughput
The throughput to the underlying storage for the entity
Measured in KB/s
- Latency

The utilization of latency allocated for the VStorage on the VM

Measured in milliseconds (ms)

Cloud VM Actions

- **Scale**

Change the VM instance to use a different instance type or tier to optimize performance and costs.

- **Increase RI Coverage / Buy RI**

If you have a high percentage of on-demand VMs, you can reduce your monthly costs by increasing coverage. To increase coverage, you scale VMs to instance types that have existing capacity. If you need more RI capacity, then Turbonomic will recommend Buy RI actions.

For scale actions, you can choose **Cloud Scale All**, **Cloud Scale for Performance**, or **Cloud Scale for Savings**.

- You can direct Turbonomic to only execute cloud VM scaling actions that improve performance (*Cloud Scale for Performance*) or reduce costs (*Cloud Scale for Savings*). The default action mode for these actions is *Manual*. When you examine the pending actions, only actions that satisfy the policy are allowed to execute. All other actions are read-only.
- *Cloud Scale All* enables all scaling actions, including those that result in efficiency improvements and increased costs.

Note:

The *Move/Compute Scale* action available in version 7.22.5 or earlier has been separated into two actions starting in version 7.22.6 – *Move* (for on-prem VMs) and *Cloud Compute Scale* (for cloud VMs). In version 8.0.5, *Cloud Compute Scale* has been renamed *Cloud Scale All*.

If you disabled *Move/Compute Scale* and then updated to 7.22.6 or later, only *Move* actions are disabled. To apply the same action to cloud VMs, create policies for the affected VMs and then disable *Cloud Scale All*.

- When policy conflicts arise, **Cloud Scale All** overrides the other two scaling options in most cases. For more information, see [Relationship Between Scoped and Default Policies](#).

Cloud VMs with Failed Sizing

For workload on the public cloud, if Turbonomic tries to execute a scale action but the action fails, then Turbonomic places the affected VM in a special group named *Cloud VMs with Failed Sizing*. Under normal circumstances this group will be empty. But in case some actions have failed, you can review the contents of this group to inspect the individual VMs. As soon as Turbonomic successfully executes a scale action on a VM in this group, it then removes the VM from the group.

Note:

When Turbonomic places a VM in this group, it restarts the VM to ensure that it is running correctly with its original configuration.

By default Turbonomic does not include any action policies for this group. Whatever action mode is set to the given VMs remains in effect while the VMs are in this group. You can create a policy and scope the policy to this group. For example, assume you see typical failures for actions that Turbonomic tries to execute during working hours. In that case, you can create a scheduling window that enables scale actions during off hours. That can help to automatically execute the actions and remove the VMs from this group.

Note that the VMs in this group could already be in a scope that is affected by another actions policy. Remember that with competing policies, the most conservative policy wins. When working with the Cloud VMs with Failed Sizing group, this can have unintended consequences. Assume you have VMs with automated scale actions, and you create a policy the sets the action mode to Manual for this group. Assume a failed scale action places a VM into this group. In that case the more conservative action

mode takes effect, and the VM will use Manual mode. Because of a failed scale action, the VM does not automate subsequent scale actions.

Actions for Kubernetes Nodes (VMs)

Provision

Provision nodes to address workload congestion or meet application demand.

When recommending node provision actions, Turbonomic also recommends pod provision actions that reflect the projected demand from required DaemonSet pods, and respects the maximum number of pods allowed for a node. This ensures that any application workload can be placed on the new node and stay within the desired range of vMem/vCPU usage, vMem/vCPU request, and number of consumers.

The action details for a node provision action show the related DaemonSet pods that are required for the node to run. Click a pod name to set it at your scope.

Action Details < 1 of 3 > ? X

Provision Virtual Machine similar to node1 **PERFORMANCE**

VCPUs Congestion

VIRTUAL MACHINE DETAILS

CONTAINER CLUSTER
Kubernetes-Turbonomic

TAGS
kubernetes.io/hostname: node1 kubernetes.io/arch: amd64 kubernetes.io/os: linux storagenode: glusterfs
beta.kubernetes.io/arch: amd64 beta.kubernetes.io/os: linux

VIRTUAL CPU
20.7 GHz

VIRTUAL MEMORY
62.8 GiB

ACTION STATE
Action acceptance is blocked by policy or system. Acceptance mode is Recommend.

RELATED ACTIONS

CAUSING

- Provision Container Pod similar to kube-system/calico-node-5cfzg
- Provision Container Pod similar to default/glusterfs-gkdgx
- Provision Container Pod similar to turbonomic/prometheus-node-exporter-hdfhk
- Provision Container Pod similar to kube-system/nodelocaldns-2pcw6
- Provision Container Pod similar to kube-system/kube-proxy-lkqj4

Suspend

Suspend nodes after you have consolidated pods or defragmented node resources to improve infrastructure efficiency.

When recommending node suspension actions, Turbonomic also recommends suspending the DaemonSet pods that are no longer required to run the suspended nodes.

The action details for a node suspension action show the related DaemonSet pods that are no longer needed to run the suspended nodes. Click a pod name to set it at your scope.

Action Details

< 1 of 2 >

Suspend Virtual Machine ocp47demo-2v5jc-worker-us-east-2a-ctc7p

Improve infrastructure efficiency

↓ \$280.00/mo
SAVINGS

VIRTUAL MACHINE DETAILS

NAME ocp47demo-2v5jc-worker...	ID i-0ae58b02dc839bcd6	AGE 30+ day(s)	ACCOUNT Advanced Engineering
--	----------------------------------	--------------------------	--

CONTAINER CLUSTER
Kubernetes-AWS-OCP-47

TAGS
kubernetes.io/cluster/ocp47demo-2v5jc: owned

VIRTUAL CPU 25.2 GHz	VIRTUAL MEMORY 30.6 GiB	NUMBER OF CONSUMERS 250
--------------------------------	-----------------------------------	-----------------------------------

COST IMPACT

ON-DEMAND RATE ⓘ \$0.384/h	ON-DEMAND COST ⓘ \$0.384/h
--------------------------------------	--------------------------------------

STATE
Action acceptance is blocked by policy or system.
Acceptance mode is Recommend.

RELATED ACTIONS

CAUSING

- Suspend Container Pod openshift-sdn/sdn-rc94c
- Suspend Container Pod openshift-image-registry/node-ca-whzhh
- Suspend Container Pod openshift-dns/dns-default-qxr8h

The instance requirements that Turbonomic recognizes are:

- Enhanced Network Adapters

Some workloads can run on instances that support Enhanced Networking via the Elastic Network Adapter (ENA), while others can run on instances that do not offer this support. Turbonomic can recommend moving a workload that does not support ENA onto an instance that does. To make that move, you must perform the required configuration of the workload before you can execute the move. If you move a non-ENA VM to an instance that requires ENA, then AWS cannot start up the VM after the move. Before executing the move, you must enable ENA on the VM.

For information about ENA configuration, see "Enabling Enhanced Networking with the Elastic Network Adapter (ENA) on Windows Instances" in the AWS documentation.

- Linux AMI Virtualization Type

An Amazon Linux AMI can use ParaVirtual (PV) or Hardware Virtual Machine (HVM) virtualization. Turbonomic can recommend moving a PV workload to an HVM instance that does not include the necessary PV drivers.

To check the virtualization type of an instance, open the Amazon EC2 console to the Details pane, and review the Virtualization field for that instance.

- 64-bit vs 32-bit

Not all AWS instance can support a 32-bit workload. Turbonomic can recommend moving a 32-bit workload to an instance that only supports a 64-bit platform.

- NVMe Block

Some instances expose EBS volumes as NVMe block devices, but not all workloads are configured with NVMe drivers. Turbonomic can recommend moving such a workload to an instance that supports NVMe. Before executing the move, you must install the NVMe drivers on the workload.

In addition, Turbonomic recognizes processor types that you currently use for your workloads. For move or resize actions, Turbonomic keeps your workloads on instance types with compatible processors:

- GPU-based instances:

Turbonomic recognizes when your workload is on a GPU-based instance. To ensure the workload always stays on a compatible processor, Turbonomic does not recommend resize actions.

- ARM-based instances

If your workload is on an ARM-based instance, then Turbonomic will only recommend resizes to other compatible ARM-based instance types.

Resizing Storage Capacity in AWS Environments

When a VM needs more storage capacity Turbonomic recommends actions to move the it to an instance that provides more storage. Note that AWS supports both Elastic Block Store (EBS) and Instance storage. Turbonomic recognizes these storage types as it recommends storage actions.

If the root storage for your workload is Instance Storage, then Turbonomic will not recommend a storage action. This is because Instance Storage is ephemeral, and such an action would cause the workload to loose all the stored data.

If the root storage is EBS, then Turbonomic recommends storage actions. EBS is persistent, and the data will remain after the action. However, if the workload uses Instance Storage for extra storage, then Turbonomic does not include that storage in its calculations or actions.

Action Details for AWS Workloads

In AWS environments, Turbonomic considers a VM's used and reserved memory to calculate virtual memory utilization, and drives actions based on the calculated value. This may not always match the values seen in CloudWatch or at the OS level of the VM.

According to the *AWS FAQ*, "In C5, portions of the total memory for an instance are reserved from use by the Operating System including areas used by the virtual BIOS for things like ACPI tables and for devices like the virtual video RAM." When Turbonomic recommends moving to one of these instances, the action details use the capacity that is reported by the instance template. However, subsequent reporting of the Mem capacity for the given instance uses the values that Turbonomic discovers in the environment.

Azure VMs

Azure Resource Group Discovery

To discover Azure Resource Groups, you can set up the following targets:

- Microsoft Azure service principle targets
- Microsoft Azure Enterprise Agreement (EA) targets

For Azure environments that include Resource Groups, Turbonomic discovers the Azure Resource Groups and the tags that are used to identify these groups.

In the Turbonomic user interface, to search for a specific Azure Resource Group, choose **Resource Groups** in the Search Page.

You can set the scope of your Turbonomic session to an Azure Resource Group by choosing a group in the Search results and clicking **Scope To Selection**.

You can also use Azure tags as filter criteria when you create a custom Turbonomic resource group. You can choose the Azure Resource Groups that match the tag criteria to be members of the new custom group.

To find the available tags for a specific Azure Resource Group, add the Basic Info chart configured with Related Tag Information to your view or custom dashboard. See [Basic Info Charts](#).

Azure Instance Requirements

In Azure environments, some instance types require workloads to be configured in specific ways, and some workload configurations require instance types that support specific features. When Turbonomic generates resize actions in Azure, these actions consider the following features:

- Accelerated Networking (AN)

In an Azure environment, not all instance types support AN, and not all workloads on AN instances actually enable AN. Turbonomic maintains a dynamic group of workloads that have AN enabled, and it assigns a policy to that group to exclude any templates that do not support AN. In this way, if a workload is on an instance that supports AN, and that workload has enabled AN, then Turbonomic will not recommend an action that would move the workload to a non-AN instance.

- Azure Premium Storage

Turbonomic recognizes whether a workload uses Premium Storage, and will not recommend a resize to an instance that does not support Azure Premium Storage.

In addition, Turbonomic recognizes processor types that you currently use for your workloads. If your workload is on a GPU-based instance, then Turbonomic will only recommend moves to other compatible GPU-based instance types. For these workloads, Turbonomic does not recommend resize actions.

Performance Metrics for Azure VMs

To analyze the utilization of Azure VM resources, Turbonomic collects performance metrics (such as memory and CPU usage) from Azure periodically. It collects metrics in the following ways:

- Azure storage account
- For VMs with basic diagnostics enabled, Turbonomic collects performance metrics that Azure publishes via this storage account.

- Azure Monitor Log Analytics

Rather than enabling diagnostics on a per-VM basis, you may have created [Azure Monitor Log Analytics](#) workspaces to centralize the management of your Azure VM configurations. Turbonomic discovers these workspaces when you add Azure targets, and then retrieves performance metrics periodically.

If you have configured your Log Analytics workspace in a separate Azure subscription that is *not* configured as a Turbonomic target, then Turbonomic service accounts for Azure targets must have one of the following built-in roles in addition to other required permissions:

- Reader
- Log Analytics Reader

For more information, see [Microsoft Azure](#).

IOPS-aware Scaling for Azure VMs

Turbonomic considers IOPS utilization when making scaling decisions for Azure VMs. To measure utilization, Turbonomic takes into account a variety of attributes, such as per-disk IOPS utilization, whole VM IOPS utilization, cache settings, and IOPS capacity for the VMs. It also respects IOPS utilization and aggressiveness constraints that you set in VM policies. For details, see [Aggressiveness and Observation Periods](#).

Analysis impacts VM scaling decisions in different ways. For example:

- If your instance experiences IOPS bottlenecks, Turbonomic can recommend scaling up to a larger instance type to increase IOPS capacity, even if you do not fully use the current VCPU or VMEM resources.
- If your instance experiences underutilization of VMEM and VCPU, but high IOPS utilization, Turbonomic might not recommend scaling down. It might keep you on the larger instance to provide sufficient IOPS capacity.
- If the instance experiences underutilization of IOPS capacity along with normal utilization of other resources, you might see an action to resize to an instance that is very similar to the current one. If you inspect the action details, you should see that you are changing to a less expensive instance with less IOPS capacity.

Cloud VM Uptime

For cloud VMs, Turbonomic includes *uptime* data in its cost calculations. This is especially important for VMs that do not run 24/7 and are charged on-demand rates. With uptime data, Turbonomic can calculate costs more accurately based on the amount of time a VM has been running.

The Action Details page shows uptime data for these VMs. Turbonomic calculates uptime based on the VM's age.



Key Concepts

- Uptime

A percentage value that indicates how long a VM has been running over a period of time (age)

- Age

The number of days that a VM has existed since first discovery. For VMs older than 30 days, Turbonomic displays a value of **30+ days**, but only calculates uptime over the last 30 days.

For newly discovered VMs, age is 0 (zero) on the day of discovery. If the VM is running at the time of discovery, uptime is 100%. Otherwise, uptime is 0% and remains unchanged until the VM is powered on. Turbonomic recalculates uptime every hour and then refreshes the data shown in the user interface.

Examples

- A VM that was first discovered 5 days (or 120 hours) ago and has been running for a total of 60 hours during that period has a current uptime value of 50%.
- A VM that was first discovered 2 months ago and has been running for a total of 180 hours over the last 30 days (or 720 hours) has a current uptime value of 25%.

Cost Calculations Using Uptime Data

Turbonomic uses uptime data to calculate estimated on-demand costs for your cloud VMs. For details about calculations, see [Estimated On-demand Monthly Costs for Cloud VMs](#).

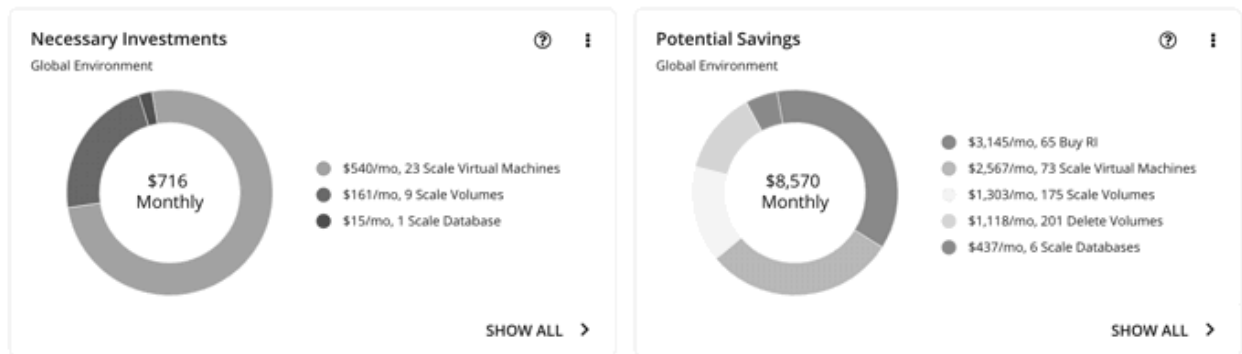
Uptime data impacts cost calculations, but not the actual scaling decisions that Turbonomic makes. These decisions rely on other factors, such as resource utilization percentiles and scaling constraints set in policies.

Uptime Data in Charts

Turbonomic recalculates uptime data every hour and then updates the values shown in charts. The following charts reflect the cost impact of uptime-based calculations:

- Potential Savings and Necessary Investment charts

The projected amounts in these charts include on-demand costs for cloud VMs.

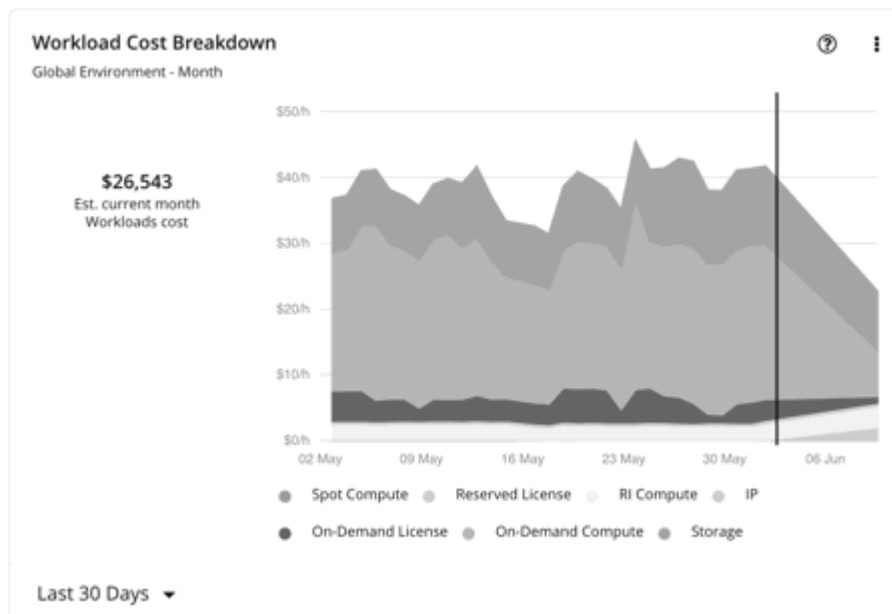


When you click **Show All** in these charts and view details for a pending VM action, the **Action Details** page shows on-demand costs before and after you execute the action, factoring in the VM's uptime value. The page also shows the VM's age.



- Workload Cost Breakdown chart

This chart shows estimated costs over time, including on-demand costs for VMs.



- The **Entity Information** chart shows the latest uptime and age data for a specific cloud VM.

Number of VCPUs	4
Region	azure-Canada East
Account	
Resource Group	
Uptime ⓘ	86.9%
Last Modification Time	N/A
Attachment State	Attached
Vendor ID [EA - PT2]	
Age ⓘ	30+ days

Estimated On-demand Costs for Cloud VMs

Turbonomic considers a variety of factors when calculating *Estimated On-demand Monthly Cost* for a cloud VM.

VIRTUAL MACHINE DETAILS							
NAME	ID	AGE	ACCOUNT	REGION			
PT_Consistent_S...		30+ days		aws-EU (Paris)			
VCPU PERCENTILE		VMEM PERCENTILE		NET THROUGHPUT		IO THROUGHPUT	
1 %	0.6 % ↓	94 %	47 % ↓	0 %	0 %	0 %	0 %
800 MHz →	1.4 GHz	1 GiB →	2 GiB	468.8 MB/s →	468.8 MB/s	260.6 MB/s →	260.6 MB/s
ON-DEMAND RATE ⓘ	RI COVERAGE ⓘ	UPTIME ⓘ	EST. ON-DEMAND MONTHLY COST ⓘ				
\$0.012/h →	50% → 0%	95.3%	\$4.1/mo → \$15/mo				

AWS VMs and Azure VMs Without License Costs

Cost Calculation

For these VMs, the calculation for Estimated On-demand Monthly Cost can be expressed as follows:

$$\text{On-demand Rate} * \text{Usage Not Covered by RIs} * \text{Uptime} * 730 = \text{Estimated On-demand Monthly Cost}$$

Where:

- **On-demand Rate** is the hourly cost for a VM's instance type *without* RI coverage.
 - For AWS, this rate includes all license costs, but not storage or IP. You can obtain on-demand rates via [Amazon EC2 On-demand Pricing](#).

- For Azure, the rate does *not* include license costs, storage, or IP. You can obtain on-demand rates via [Azure Pricing Calculator](#).

Note:

Azure VMs covered by Azure Hybrid Benefit do not have license costs.

- **Usage Not Covered by RIs** is the percentage of hourly VM usage not covered by any RI. For example:
 - RI Coverage = 20% (0.2)
 - Usage Not Covered by RIs = 80% (0.8)
- **Uptime** is a percentage value that indicates how long a VM has been running over a period of time (age). Age refers to the number of days that a VM has existed since first discovery. For VMs older than 30 days, Turbonomic only calculates uptime over the last 30 days.

To estimate monthly on-demand costs, Turbonomic projects the current uptime value into the future. It assumes that future uptime will be similar to the current uptime.

- **730** represents the number of hours per month that Turbonomic uses to estimate monthly costs.

The listed items above impact cost calculations, but not the actual scaling decisions that Turbonomic makes. These decisions rely on other factors, such as resource utilization percentiles and scaling constraints set in policies.

Example

Assume the following data for a pending scale action for an AWS VM:

VIRTUAL MACHINE DETAILS							
NAME	ID	AGE	ACCOUNT	REGION			
PT_Consistent_S...		30+ days		aws-EU (Paris)			
VCPU PERCENTILE		VMEM PERCENTILE		NET THROUGHPUT		IO THROUGHPUT	
1 %	0.6 %	94 %	47 %	0 %	0 %	0 %	0 %
800 MHz	1.4 GHz	1 GiB	2 GiB	468.8 MB/s	468.8 MB/s	260.6 MB/s	260.6 MB/s
ON-DEMAND RATE ⓘ		RI COVERAGE ⓘ		UPTIME ⓘ		EST. ON-DEMAND MONTHLY COST ⓘ	
\$0.012/h → \$0.021/h		50% → 0%		95.3%		\$4.1/mo → \$15/mo	

	Current Values	Values After Action Execution
On-demand Rate	\$0.012/hr	\$0.021/hr
RI Coverage	50% (0.5)	0% (0.0)
Usage Not Covered by RIs (calculated based on RI coverage)	50% (0.5)	100% (1.0)
Uptime	95.3% (.953)	

Turbonomic calculates the following:

VIRTUAL MACHINE DETAILS							
NAME		ID	AGE		ACCOUNT		REGION
PT_Consistent_S...			30+ days				aws-EU (Paris)
VCPU PERCENTILE		VMEM PERCENTILE		NET THROUGHPUT		IO THROUGHPUT	
1 %	0.6 % ↓	94 %	47 % ↓	0 %	0 %	0 %	0 %
800 MHz →	1.4 GHz	1 GiB →	2 GiB	468.8 MB/s →	468.8 MB/s	260.6 MB/s →	260.6 MB/s
ON-DEMAND RATE ⓘ		RI COVERAGE ⓘ		UPTIME ⓘ		EST. ON-DEMAND MONTHLY COST ⓘ	
\$0.012/h → \$0.021/h		50% → 0%		95.3%		\$4.1/mo → \$15/mo	

- *Current* Estimated On-demand Monthly Cost:

$$0.012 * 0.5 * 0.953 * 730 = 4.1$$

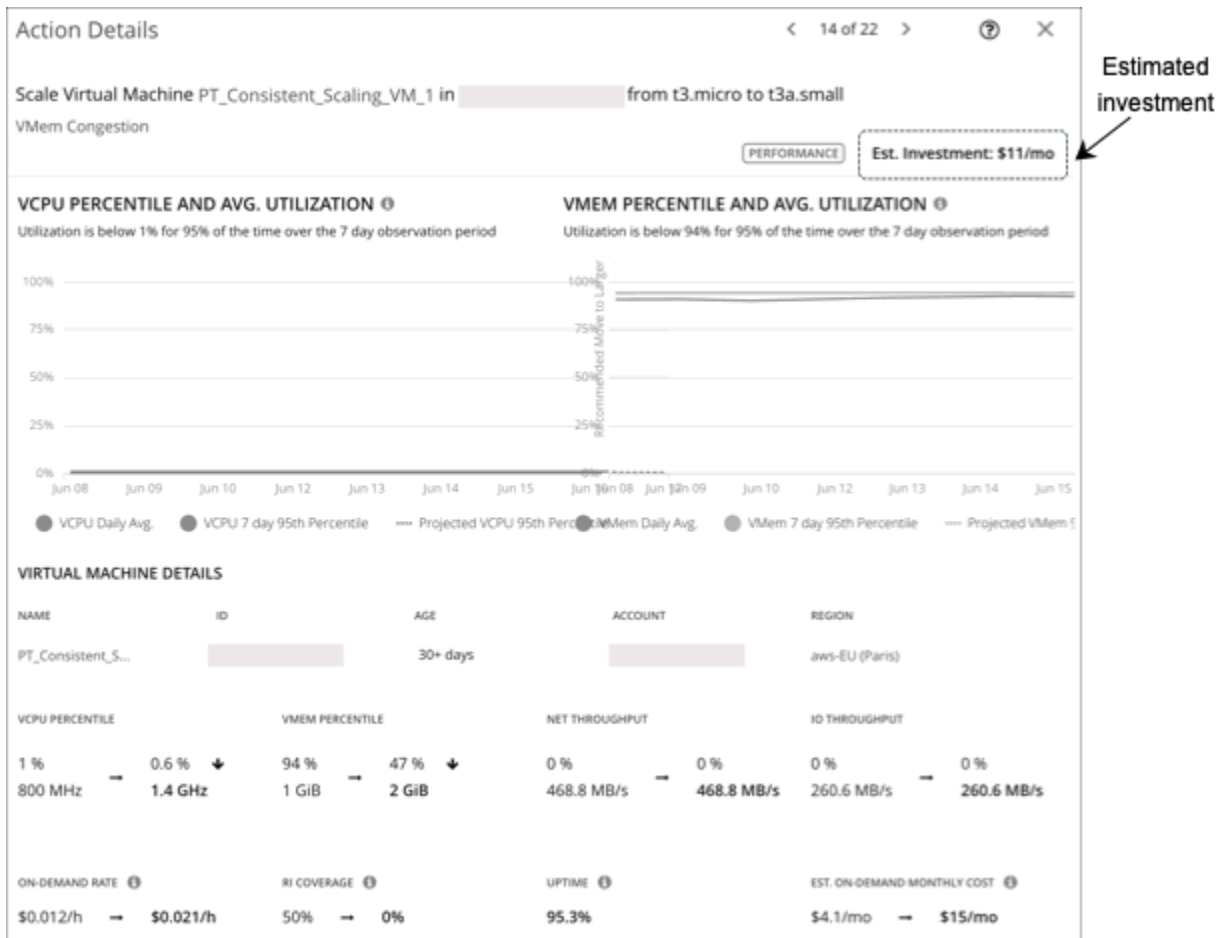
- Estimated On-demand Monthly Cost *after* executing the action:

$$0.021 * 1.0 * 0.953 * 730 = 15$$

Note:

Turbonomic rounds the calculated values that it displays in the user interface.

Since the Estimated On-demand Monthly Cost is projected to increase from \$4.1/month to \$15/month, Turbonomic treats the action as an investment and shows an estimated investment of \$11/month.



Azure VMs with License Costs

Cost Calculation

For VMs with license costs, Turbonomic first calculates the *On-demand Compute Rate*, which it then uses to calculate *Estimated On-demand Monthly Costs*.

1. On-demand Compute Rate Calculation

The calculation for On-demand Compute Rate can be expressed as follows:

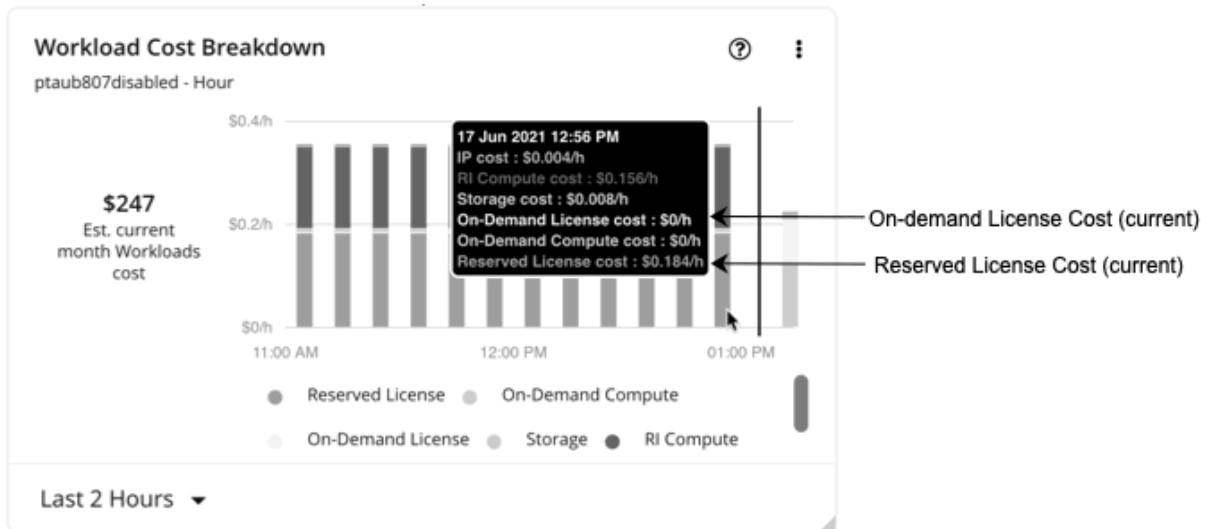
$$\text{On-demand Rate} - (\text{Reserved License Cost} + \text{On-demand License Cost}) = \text{On-demand Compute Rate}$$

Where:

- **On-demand Rate** is the hourly cost for a VM's instance type *without* RI coverage. This does *not* include license costs, storage, or IP. You can obtain on-demand rates via [Azure Pricing Calculator](#).
- **Reserved License Cost** and **On-demand License Cost** are the hourly costs for the VM's licenses. You can obtain license costs via Azure Pricing Calculator or the Turbonomic user interface.

From the user interface, set the scope to the Azure VM and then see the Workload Cost Breakdown chart. In the chart, set the time frame to Last 2 Hours, and then:

- Hover over the second to the last bar in the chart to obtain the *current* On-demand License Cost and Reserved License Cost.



- Hover over the last bar (after the vertical line) in the chart to obtain the On-demand License Cost and Reserved License Cost *after* you execute actions.



The *On-demand Compute Rate* and *License Cost (On-demand and Reserved)* are then used to calculate Estimated On-demand Monthly Costs.

2. Estimated On-demand Monthly Cost Calculation

The calculation can be expressed as follows:

$$(\text{On-demand Compute Rate} * \text{Usage Not Covered by RIs}) + \text{License Cost} * \text{Uptime} * 730 = \text{Estimated On-demand Monthly Cost}$$

Where:

- **Usage Not Covered by RIs** is the percentage of hourly VM usage not covered by any RI. For example:
 - RI Coverage = 20% (0.2)
 - Usage Not Covered by RIs = 80% (0.8)
- **License Cost** is the sum of On-demand License Cost and Reserved License Cost.
- **Uptime** is a percentage value that indicates how long a VM has been running over a period of time (age). Age refers to the number of days that a VM has existed since first discovery. For VMs older than 30 days, Turbonomic only calculates uptime over the last 30 days.

To estimate monthly on-demand costs, Turbonomic projects the current uptime value into the future. It assumes that future uptime will be similar to the current uptime.

- **730** represents the number of hours per month that Turbonomic uses to estimate monthly costs.

The listed items above impact cost calculations, but not the actual scaling decisions that Turbonomic makes. These decisions rely on other factors, such as resource utilization percentiles and scaling constraints set in policies.

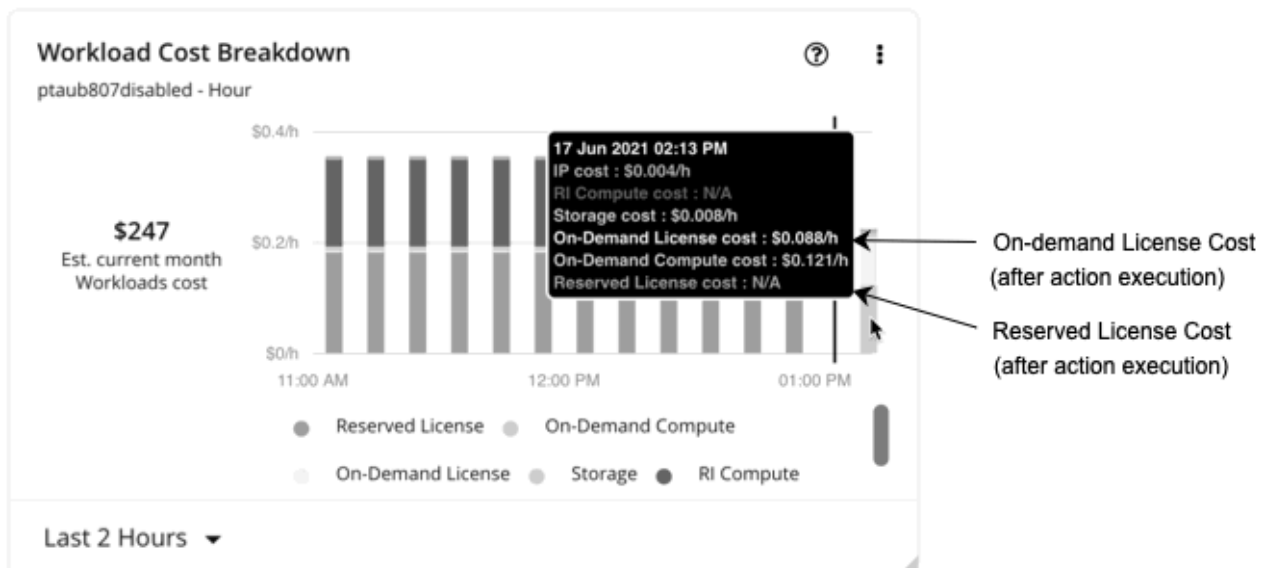
Example

Assume the following data for a pending scale action for an Azure VM with license costs:

VIRTUAL MACHINE DETAILS				
NAME	ID	AGE	SUBSCRIPTION	LOCATION
ptaub807disable...	25b9c0ce-0e08-4...	30+ days	EA - Development	azure-East US 2
VCPU PERCENTILE		VMEM PERCENTILE		VM IOPS PERCENTILE
2 %	2.9 % ↑	9 %	18 % ↑	0 %
33.2 GHz	22.7 GHz	32 GiB	16 GiB	6,400 IOPS
				3,200 IOPS
				VM STORAGE THROUGHPUT PERCENTILE
				0 %
				0 %
				96 MB/s
				48 MB/s
ON-DEMAND RATE ⓘ		RI COVERAGE ⓘ		UPTIME ⓘ
\$0.45/h → \$0.218/h		100% → 0%		96.1%
				EST. ON-DEMAND MONTHLY COST ⓘ
				\$129/mo → \$153/mo

	Current Values	Values After Action Execution
On-demand Rate	\$0.45/hr	\$0.218/hr





	Current Values	Values After Action Execution
On-demand License Cost	\$0/hr	\$0.088/hr
Reserved License Cost	\$0.184/hr	N/A

1. Turbonomic first calculates the following:

- *Current* On-demand Compute Rate:

$$0.45 - (0.184 + 0) = 0.266$$

- On-demand Compute Rate *after* executing the action:

$$0.218 - (0 + 0.088) = 0.13$$

2. Turbonomic can now calculate Estimated On-demand Monthly Cost based on:

- On-demand Compute Rate

	Current Values	Values After Action Execution
On-demand Compute Rate	\$0.266/hr	\$0.13/hr

- Usage Not Covered by RIs and Uptime

VIRTUAL MACHINE DETAILS				
NAME	ID	AGE	SUBSCRIPTION	LOCATION
ptaub807disable...	25b9c0ce-0e08-4...	30+ days	EA - Development	azure-East US 2
VCPU PERCENTILE		VMEM PERCENTILE		VM IOPS PERCENTILE
2 %	2.9 % ↑	9 %	18 % ↑	0 %
33.2 GHz	22.7 GHz	32 GiB	16 GiB	6,400 IOPS
				3,200 IOPS
VM STORAGE THROUGHPUT PERCENTILE				
0 %	0 %			
96 MB/s	48 MB/s			
ON-DEMAND RATE ⓘ	RI COVERAGE ⓘ	UPTIME ⓘ	EST. ON-DEMAND MONTHLY COST ⓘ	
\$0.45/h → \$0.218/h	100% → 0%	96.1%	\$129/mo → \$153/mo	

	Current Values	Values After Action Execution
RI Coverage	100% (1.0)	0% (0.0)
Usage Not Covered by RIs (calculated based on RI coverage)	0% (0.0)	100% (1.0)
Uptime	96.1% (.961)	

Turbonomic calculates the following:

VIRTUAL MACHINE DETAILS				
NAME	ID	AGE	SUBSCRIPTION	LOCATION
ptaub807disable...	25b9c0ce-0e08-4...	30+ days	EA - Development	azure-East US 2
VCPU PERCENTILE		VMEM PERCENTILE		VM IOPS PERCENTILE
2 %	2.9 % ↑	9 %	18 % ↑	0 %
33.2 GHz	→ 22.7 GHz	32 GiB	→ 16 GiB	6,400 IOPS
				→ 3,200 IOPS
				VM STORAGE THROUGHPUT PERCENTILE
				0 %
				0 %
				96 MB/s
				→ 48 MB/s
ON-DEMAND RATE ⓘ	RI COVERAGE ⓘ	UPTIME ⓘ	EST. ON-DEMAND MONTHLY COST ⓘ	
\$0.45/h	100%	96.1%	\$129/mo	
→ \$0.218/h	→ 0%		→ \$153/mo	

- *Current* Estimated On-demand Monthly Cost:

$$(0.266 * 0.0) + 0.184 * 0.961 * 730 = 129$$

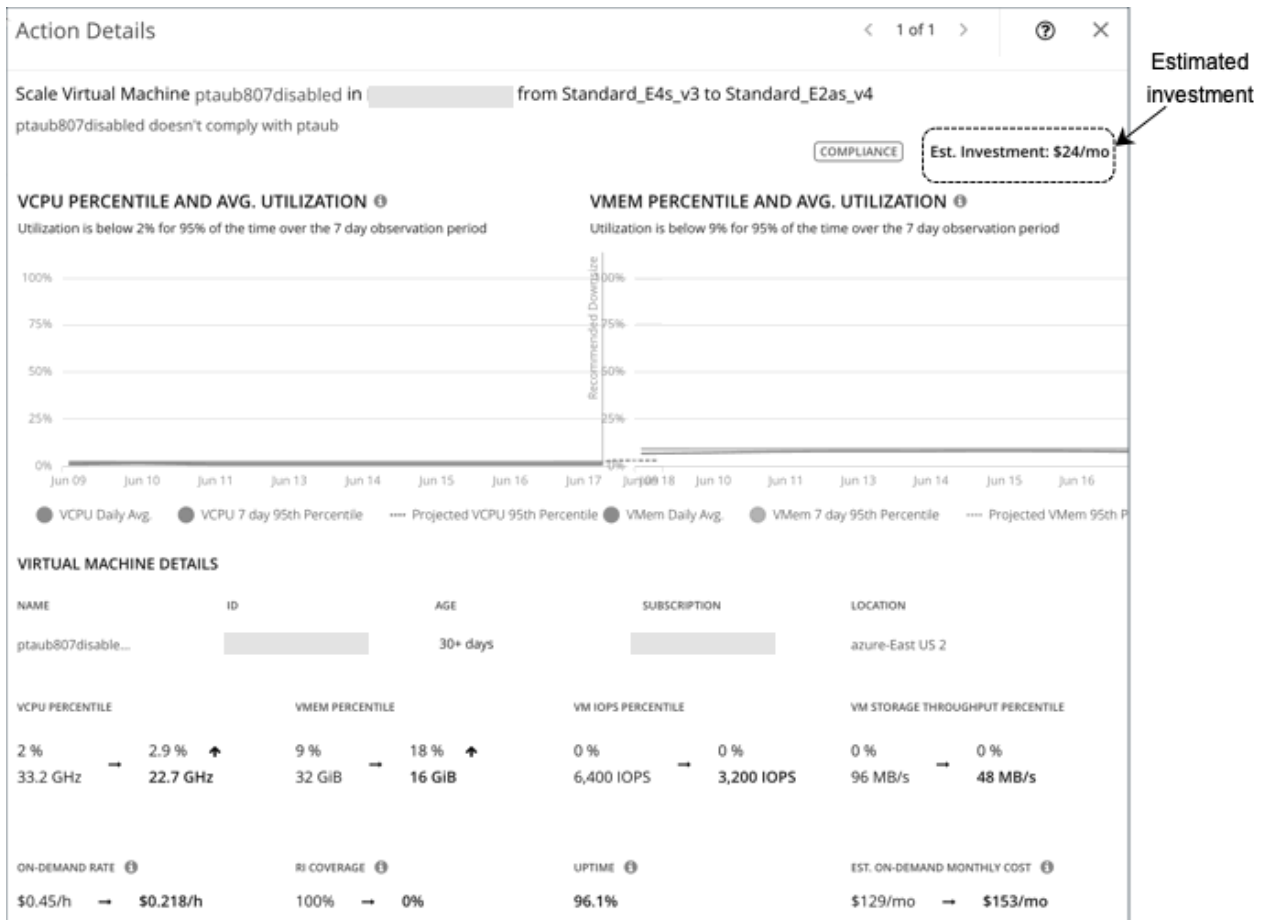
- Estimated On-demand Monthly Cost *after* executing the action:

$$(0.13 * 1.0) + 0.088 * 0.961 * 730 = 153$$

Note:

Turbonomic rounds the calculated values that it displays in the user interface.

Since the on-demand cost is projected to increase from \$129/month to \$153/month, Turbonomic treats the action as an investment and shows an estimated investment of \$24/month.



Cloud VM Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.







Action Automation and Orchestration

For details about cloud VM actions, see [Cloud VM Actions](#).

Cloud Scale

Action	Default Mode	AWS	Azure
Cloud Scale All	Manual	Auto	Auto
Cloud Scale for Performance	Manual	Auto	Auto
Cloud Scale for Savings	Manual	Auto	Auto

Other Actions

Action	Default Mode	AWS	Azure
Buy RI	Recommend		
Provision Kubernetes node (VM)	Manual		
Suspend Kubernetes node (VM)	Manual		

Scaling Target Utilization

For VCPU, VMEM, and IO/Net Throughput Utilization:

These advanced settings determine how much you would like a scope of workloads to utilize their resources. These are fixed settings that override the way Turbonomic calculates the optimal utilization of resources. You should only change these settings after consulting with Technical Support.

While these settings offer a way to modify how Turbonomic recommends actions, in most cases you should never need to use them. If you want to control how Turbonomic recommends actions to resize workloads, you can set the aggressiveness per the percentile of utilization, and set the length of the sample period for more or less elasticity on the cloud.

Attribute	Default Value
Scaling Target VCPU Utilization	70 The target utilization as a percentage of VCPU capacity.
Scaling Target VMEM Utilization	90 The target utilization as a percentage of memory capacity.
Scaling Target IO Throughput Utilization	70 The target utilization as a percentage of IO throughput (Read and Write) capacity.
Scaling Target Net Throughput Utilization	70 The target utilization as a percentage of network throughput (Inbound and Outbound) capacity.

For IOPS Utilization:

Turbonomic uses this setting in conjunction with aggressiveness constraints to control scaling actions for VMs. You can set the aggressiveness per the percentile of utilization, and set the length of the sample period for more or less elasticity on the cloud.

Attribute	Default Value
Scaling Target IOPS Utilization (Azure VMs only)	70 For Azure environments, the target percentile value Turbonomic will attempt to match.

For details on how IOPS utilization affects scaling decisions, see [IOPS-aware Scaling for Azure VMs](#).

Aggressiveness and Observation Periods

Turbonomic uses these settings to calculate utilization percentiles for vCPU, vMEM, and IOPS (Azure VMs only). It then recommends actions to improve utilization based on the observed values for a given time period.

• Aggressiveness

Attribute	Default Value
Aggressiveness	95th Percentile

When evaluating performance, Turbonomic considers resource utilization as a percentage of capacity. The utilization drives actions to scale the available capacity either up or down. To measure utilization, the analysis considers a given utilization percentile. For example, assume a 95th percentile. The percentile utilization is the highest value that 95% of the observed samples fall below. Compare that to average utilization, which is the average of *all* the observed samples.

Using a percentile, Turbonomic can recommend more relevant actions. This is important in the cloud, so that analysis can better exploit the elasticity of the cloud. For scheduled policies, the more relevant actions will tend to remain viable when their execution is put off to a later time.

For example, consider decisions to reduce the capacity for CPU on a VM. Without using a percentile, Turbonomic never resizes below the recognized peak utilization. For most VMs, there are moments when peak CPU reaches high levels, such as during reboots, patching, and other maintenance tasks. Assume utilization for a VM peaked at 100% just once. Without the benefit of a percentile, Turbonomic will not reduce allocated CPU for that VM.

With **Aggressiveness**, instead of using the single highest utilization value, Turbonomic uses the percentile you set. For the above example, assume a single CPU burst to 100%, but for 95% of the samples CPU never exceeded 50%. If you set **Aggressiveness** to 95th Percentile, then Turbonomic can see this as an opportunity to reduce CPU allocation for the VM.

In summary, a percentile evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, as follows:

- 100th and 99th Percentile – More performance. Recommended for critical workloads that need maximum guaranteed performance at all times, or workloads that need to tolerate sudden and previously unseen spikes in utilization, even though sustained utilization is low.
- 95th Percentile (Default) – The recommended setting to achieve maximum performance and savings. This assures application performance while avoiding reactive peak sizing due to transient spikes, thus allowing you to take advantage of the elastic ability of the cloud.
- 90th Percentile – More efficiency. Recommended for non-production workloads that can stand higher resource utilization.

By default, Turbonomic uses samples from the last 30 days. Use the **Max Observation Period** setting to adjust the number of days. To ensure that there are enough samples to analyze and drive scaling actions, set the **Min Observation Period**.

• Max Observation Period

Attribute	Default Value
Max Observation Period	Last 30 Days

To refine the calculation of resource utilization percentiles, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. If the database has fewer days' data then it uses all of the stored historical data.

You can make the following settings:

- Less Elastic – Last 90 Days
- Recommended – Last 30 Days
- More Elastic – Last 7 Days

Turbonomic recommends an observation period of 30 days following the monthly workload maintenance cycle seen in many organizations. VMs typically peak during the maintenance window as patching and other maintenance tasks are carried out. A 30-day observation period means that Turbonomic can capture these peaks and increase the accuracy of its sizing recommendations.

You can set the value to 7 days if workloads need to resize more often in response to performance changes. For workloads that cannot handle changes very often or have longer usage periods, you can set the value to 90 days.

- **Min Observation Period**

Attribute	Default Value
Min Observation Period	None

This setting ensures historical data for a minimum number of days before Turbonomic will generate an action based on the percentile set in **Aggressiveness**. This ensures a minimum set of data points before it generates the action.

Especially for scheduled actions, it is important that resize calculations use enough historical data to generate actions that will remain viable even during a scheduled maintenance window. A maintenance window is usually set for "down" time, when utilization is low. If analysis uses enough historical data for an action, then the action is more likely to remain viable during the maintenance window.

- More Elastic – None
- Less Elastic – 7 Days

Cloud Instance Types

Attribute	Default Value
Cloud Instance Types	None

By default, Turbonomic considers all instance types currently available for scaling when making scaling decisions for VMs. However, you may have set up your cloud VMs to *only scale to* or *avoid* certain instance types to reduce complexity and cost, improve RI utilization, or meet application demand. Use this setting to identify the instance types that VMs can scale to.

Click **Edit** to set your preferences. In the new page that displays, expand a **cloud tier** (a family of instance types, such as *a1* for AWS or *B-series* for Azure) to see individual instance types and the resources allocated to them. If you have several cloud providers, each provider will have its own tab.

Select your preferred instance types or cloud tiers, or clear the ones that you want to avoid. After you save your changes, the main page refreshes to reflect your selections.

If you selected a cloud tier and the service provider deploys new instance types to that tier later, then those instance types will automatically be included in your policy. Be sure to review your policies periodically to see if new instance types have been added to a tier. If you do not want to scale to those instance types, update the affected policies.

Consistent Resizing

Attribute	Default Setting
Enable Consistent Resizing	Off

For groups in scoped policies:

When you create a policy for a group of VMs and turn on Consistent Resizing, Turbonomic resizes all the group members to the same size, such that they all support the top utilization of each resource commodity in the group. For example, assume VM A shows top utilization of CPU, and VM B shows top utilization of memory. A resize action would result in all the VMs with CPU capacity to satisfy VM A, and memory capacity to satisfy VM B.

For an affected resize, the Actions List shows individual resize actions for each of the VMs in the group. If you automate resizes, Turbonomic executes each resize individually in a way that avoids disruption to your workloads.

Use this setting to enforce the same template across all VMs in a group when resizing VMs on the public cloud. In this way, Turbonomic can enforce a rule to size all the VMs in a group equally.

For auto-discovered groups:

In public cloud environments, Turbonomic discovers groups that should keep all their VMs on the same template, and then creates read-only policies for them to implement Consistent Resizing. The details of this discovery and the associated policy vary depending on the Cloud Provider.

- Azure

Turbonomic discovers Azure availability sets and scale sets.

- For availability sets, Turbonomic does *not* enable Consistent Resizing, but it can recommend scale actions for individual VMs in the availability set.

When a scale action for a VM in an availability set fails due to insufficient resources in the compute cluster, the action remains pending. When you hover over the pending action, you will see a message indicating that action execution has been temporarily disabled due to a previous execution error in the availability set. Turbonomic assumes that all other VMs in the availability set will fail to scale due to the same resource issue, so it creates a temporary policy that disables action execution for the availability set. Specifically, this policy sets the action mode for scale actions to *Recommend* and stays in effect for 730 hours (one month). This means that for the duration of the policy, Turbonomic will continue to generate read-only, non-executable scale actions for individual VMs, so you can evaluate their resource requirements and plan accordingly. You can delete this policy if you need to re-enable action execution in the availability set.

- For scale sets, Turbonomic automatically enables Consistent Resizing across all the VMs in the group. You can choose to execute all the actions for such a group, either manually or automatically. In that case, Turbonomic executes the resizes one VM at a time. If you do not need to resize all the members of a given scale set to a consistent template, create another policy for that scope and turn off Consistent Resizing.

- AWS

Turbonomic discovers Auto Scaling Groups and automatically enables Consistent Resizing across all the VMs in each group. You can choose to execute all the actions for such a group, either manually or automatically. In that case, Turbonomic executes the resizes one VM at a time. If you do not need to resize all the members of a given Auto Scaling Group to a consistent template, create another policy for that scope and turn off Consistent Resizing.

Reasons to employ Consistent Resizing for a group include:

- Load Balancing

If you have deployed load balancing for a group, then all the VMs in the group should experience similar utilization. In that case, if one VM needs to be resized, then it makes sense to resize them all consistently.

- **High Availability (HA)**

A common HA configuration on the public cloud is to deploy mirror VMs to different availability zones, where the given application runs on only one of the VMs at a given time. The other VMs are on standby to recover in failover events. Without Consistent Resizing, Turbonomic would tend to size down or suspend the unused VMs, which would make them unready for the failover situation.

When working with Consistent Resizing, consider these points:

- You should not mix VMs in a group that has a Consistent Resizing policy, with other groups that enable Consistent Resizing. One VM can be a member of more than one group. If one VM (or more) in a group with Consistent Resizing is also in another group that has Consistent Resizing, then both groups enforce Consistent Resizing together, for all their group members.
- If one VM (or more) is in a group with Consistent Resizing turned on, and the same VMs are in a group with Consistent Resizing turned off, the affected VMs assume the ON setting. This is true if you created both groups, or if Turbonomic created one of the groups for Azure Scale Sets or AWS Auto Scaling Groups.
- For any group of VMs that enables Consistent Resizing, you should not mix the associated target technologies. For example, one group should not include VMs that are managed on both Azure and AWS platforms.
- Charts that show actions and risks assign the same risk statement to all the affected VMs. This can seem confusing. For example, assume one VM needs to resize to address vCPU risk, and 9 other VMs are set to resize consistently with it. Then charts will state that 10 VMs need to resize to address vCPU risks.

Instance Store Aware Scaling

Attribute	Default Setting
Instance Store Aware Scaling	Off

The template for your workload determines whether the workload can use an *instance store*, and it determines the instance store capacity. As Turbonomic calculates a resize or move action, it can recommend a new template that does not support instance stores, or that does not provide the same instance store capacity.

To ensure that resize actions respect the instance store requirements for your workloads, turn on **Instance Store Aware Scaling** for a given VM or for a group of VMs. When you turn this on for a given scope of VMs, then as it calculates move and resize actions, Turbonomic will only consider templates that support instance stores. In addition, it will not move a workload to a template that provides less instance store capacity.

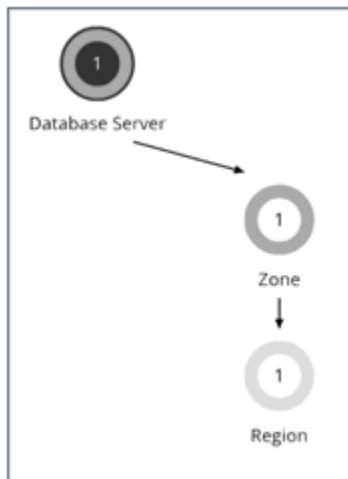
Database Server (Cloud)

In AWS public cloud environments, a Database Server is a relational database that you have configured using AWS Relational Database Service (RDS). Turbonomic discovers RDS instances through your AWS targets, and then generates scaling actions as needed.

Note:

Azure SQL Databases discovered by Turbonomic appear as *Database* entities in the supply chain. For details, see [Database \(Cloud\)](#).

Synopsis



AWS RDS

Synopsis

Budget:	A cloud Database Server has unlimited budget.
Provides:	Database services to cloud applications and end users
Consumes:	Compute and storage resources in the availability zone
Discovered through:	AWS targets

Permissions

Turbonomic requires the following permissions for AWS RDS Database Servers:

- Monitoring permissions:
 - cloudwatch:GetMetricData
 - pi:GetResourceMetrics
 - rds:DescribeDBInstances
 - rds:DescribeDBParameters
 - rds:ListTagsForResource
 - rds:DescribeOrderableDBInstanceOptions
- Action execution permissions:
 - rds:ModifyDBInstance

For a full list of permissions, see [Amazon Web Services](#).

Monitored Resources

Turbonomic monitors the following resources for a cloud Database Server:

- Virtual Memory (VMem)
 - The utilization of VMem allocated to the Database Server's instance type
- Virtual CPU (VCPU)

The utilization of VCPU allocated to the Database Server's instance type

- Storage Amount

The amount of Amazon EBS storage utilized by the Database Server

- Storage Access

IOPS utilized by the Database Server

- DB Cache Hit Rate (if available)

The percentage of database responses served through cache hits

- Connections

The number of connections to the Database Server

Actions

Scale

Scale compute and storage resources to optimize performance and costs.

To recommend accurate scaling actions, Turbonomic analyzes resource utilization percentiles and collects relevant metrics (such as connections utilization) from AWS. It also takes into consideration constraints defined in [policies](#).

Consider the following scenarios and actions:

- To address vCPU congestion, Turbonomic can recommend scaling a Database Server to the instance type that can adequately meet demand at the lowest possible cost. If vCPU is underutilized, it can recommend scaling to a smaller instance type.
- To address IOPS congestion, Turbonomic can recommend increasing provisioned IOPS or scaling the Database Server to a different storage type. For gp2 storage, it can recommend increasing disk size to increase provisioned IOPS. After executing these actions, Turbonomic will not recommend new actions for the next six hours, in compliance with AWS's "cooldown" period for EBS storage.
- Turbonomic analyzes DB cache hit rate before making vMem scaling decisions. To perform its analysis, it collects cache hit rate metrics for Database Servers with [Performance Insights](#) enabled.

For Database Servers with cache hit rate metrics, Turbonomic considers at least 90% cache hit rate to be optimal. This percentage value is not configurable.

- A cache hit rate value equal to or greater than 90% indicates efficiency. For this reason, Turbonomic will not recommend an action even if vMem utilization is high. If vMem utilization is low, it will recommend scaling to a smaller instance type.
- When the cache hit rate is below 90%, Turbonomic will also not recommend an action, provided that vMem utilization remains low. If vMem utilization is high, then it will recommend scaling to a larger instance type.

Notes on Performance Insights and cache hit rate metrics:

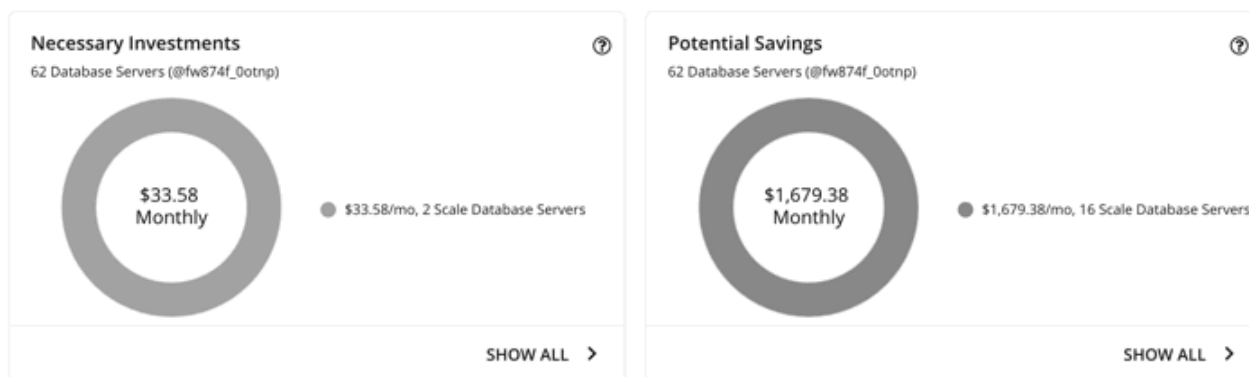
- Performance Insights is enabled by default on a majority of AWS Database Servers. In the Turbonomic user interface, you can use Search and then apply the Performance Insights filter to see which Database Servers have Performance Insights enabled.
- If Performance Insights is disabled or is not supported for your AWS Database Server engines or regions, Turbonomic will not have cache hit rate metrics to analyze and will therefore not generate actions in direct response to vMem utilization. For a list of supported engines and regions, see this [AWS page](#).
- An action to scale to a different instance type in response to vCPU utilization might also include vMem changes, but vMem utilization alone (without cache hit rate metrics) will not drive actions.

Turbonomic also considers Connections utilization and capacity when making scaling decisions. It collects utilization metrics from CloudWatch and calculates capacity based on the maximum number of simultaneous connections configured for the Database Server. The maximum number varies by Database

Server engine type and memory allocation, and is set in the [parameter group](#) associated with a Database Server. Turbonomic currently supports Database Servers associated with parameter groups that use default values. For example, consider a MySQL Database Server that is on a `db.t3.large` instance type with 8 GB (8589934592 bytes) of memory, and is associated with a parameter group that uses the default value `{DBInstanceClassMemory/12582880}`. In this case, Turbonomic calculates capacity as 682 connections (or $\{8589934592/12582880\}$). When Turbonomic generates an action due to vMem underutilization and sees that Connections utilization is only 15% of capacity (or roughly 100 connections), it picks a smaller instance type that is adequate for both the vMem and Connections requirements of the Database Server. For example, it could pick `db.t2.small`, which provides 2 GB of memory and a maximum of 170 connections.

Actions in Charts

Use the Necessary Investments and Potential Savings charts to view pending Database Server actions. These charts show total monthly investments and savings, assuming you execute all the actions.



Click **Show All** for each chart to review and execute the actions.

The table lists all the actions that are pending for Database Servers, and the savings or investments for each action.

Scale Actions 16 Savings \$1,679.38/mo

EXECUTE ACTIONS

🔍

Type to search

⌵

ADD FILTER

<input type="checkbox"/> Database Server Name	Account	Non-Disrupt...	Reversible	Instance Type	On-Demand	New Instance Type	New On-Demand	Action Category	Savings ↓	Action
<input type="checkbox"/> rds-mariamulti		✗	✓	db.t3.small-io1	\$0.924/h	db.t3.small-stand...	\$0.095/h	SAVINGS	↓ \$604.80/rr	DETAILS
<input type="checkbox"/> testioautoscaling		✗	✓	db.t3.micro-io1	\$0.446/h	db.t3.micro-gp2	\$0.033/h	SAVINGS	↓ \$301.00/rr	DETAILS
<input type="checkbox"/> rds-maria-io1		✗	✓	db.t3.micro-io1	\$0.418/h	db.t3.micro-stand...	\$0.031/h	SAVINGS	↓ \$282.50/rr	DETAILS
<input type="checkbox"/> btc-dbs-1		✗	✓	db.m5.xlarge-io1	\$0.514/h	db.r6g.large-stan...	\$0.219/h	SAVINGS	↓ \$215.20/rr	DETAILS

For details on how Turbonomic calculates savings or investments, see [Estimated On-demand Costs for Cloud Database Servers](#).

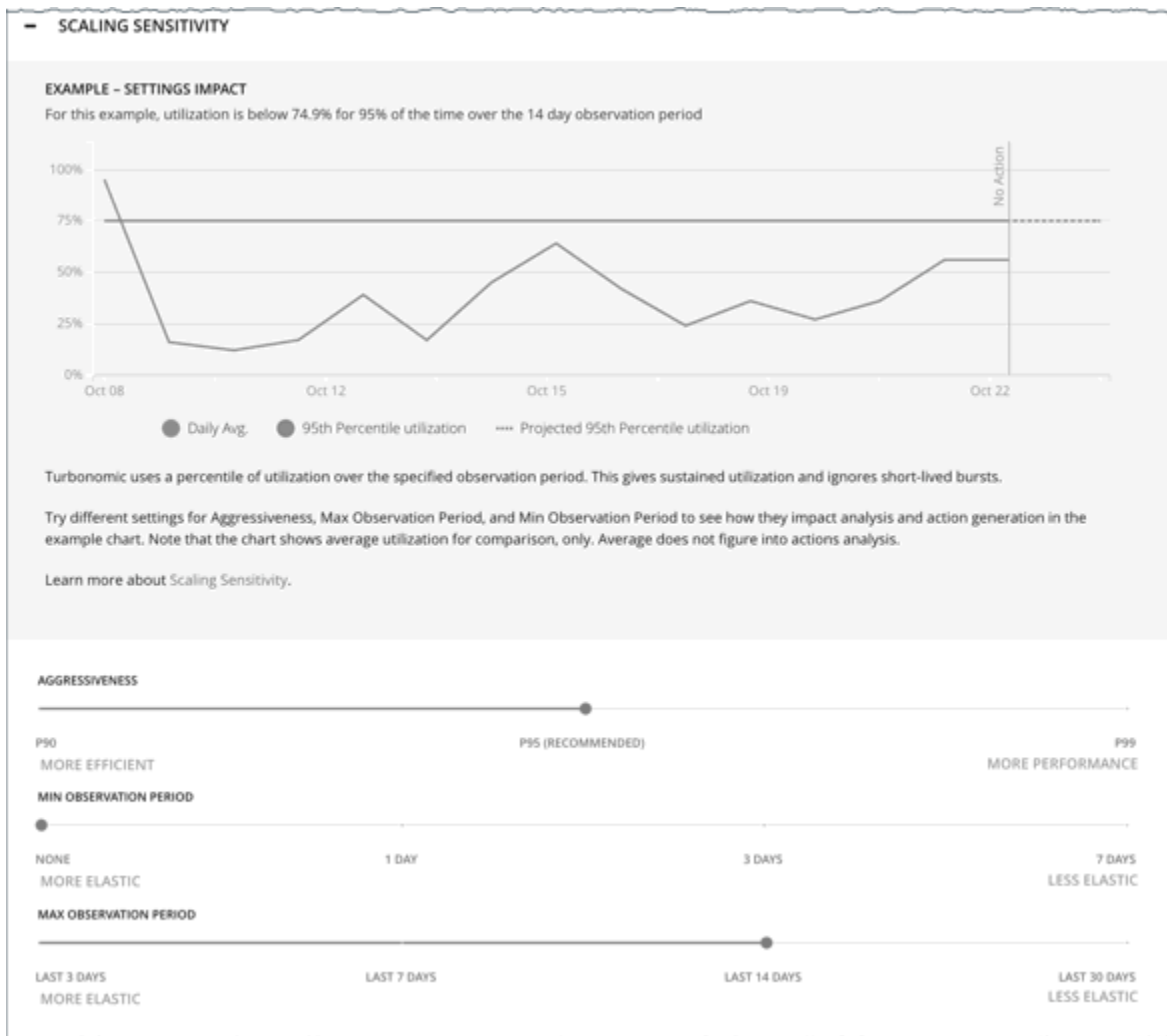
Utilization Charts

Turbonomic uses percentile calculations to measure resource utilization more accurately, and drive scaling actions that improve overall utilization and reduce costs. When you examine the details for a pending scale action on a Database Server, you will see charts that highlight *utilization percentiles* for a given observation period, and the projected percentiles after you execute the action.



The charts also plot *daily average utilization* for your reference. If you have previously executed scaling actions on the Database Server, you can see the resulting improvements in daily average utilization. Put together, these charts allow you to easily recognize utilization trends that drive Turbonomic's scaling recommendations.

You can set scaling constraints in Database Server policies to refine the percentile calculations.



For details, see [Scaling Sensitivity](#).

Non-disruptive and Reversible Scaling Actions

Turbonomic indicates whether a pending action is non-disruptive or reversible to help you decide how to handle the action.

Scale Actions 16 Savings \$1,679.38/mo					
<input type="text"/> Type to search					
<input type="checkbox"/> Database Server Name	Account	Non-Disruptive	Reversible	Instance Type	On-Demand Cost
<input type="checkbox"/> rds-mariamulti12		✗	✓	db.t3.small-io1	\$0.924/h
<input type="checkbox"/> testioautoscalingenabled		✗	✓	db.t3.micro-io1	\$0.446/h
<input type="checkbox"/> rds-maria-io1		✗	✓	db.t3.micro-io1	\$0.418/h
<input type="checkbox"/> btc-dbs-1		✗	✓	db.m5.xlarge-io1	\$0.514/h

The following table describes the disruptiveness and reversibility of the actions that Turbonomic recommends:

Action	Disruptive	Reversible
Scaling to a different instance type	Yes	Yes
Scaling up storage amount	No	No
Scaling up storage access (provisioned IOPS)	No	Yes
Scaling to a different storage type + Scaling up storage amount	Yes	No
Scaling to a different storage type + Scaling up storage access (provisioned IOPS)	Yes	Yes
Scaling to a different storage type + Scaling up storage amount + Scaling up storage access (provisioned IOPS)	Yes	No

You can set action modes in policies to specify the degree of automation for these actions.

Configure Database Server Policy

×

+

SCOPE

?

+

POLICY SCHEDULE

?

–

AUTOMATION AND ORCHESTRATION

Database Server Scaling Actions

Generate cloud database server scaling actions

DISRUPTIVE IRREVERSIBLE SCALING

AWS RDS storage amount scale and instance type or storage tier change

Action Acceptance: Recommend

DISRUPTIVE REVERSIBLE SCALING

AWS RDS instance type scaling, storage tier changes

Action Acceptance: Recommend

NON-DISRUPTIVE IRREVERSIBLE SCALING

AWS RDS storage amount scaling

Action Acceptance: Recommend

NON-DISRUPTIVE REVERSIBLE SCALING

AWS RDS provisioned IOPS scaling

Action Acceptance: Recommend

Unavailable Instance Types

A scale action could fail if the target instance type is unavailable in the availability zone for some reason. Your AWS environment might show the instance type as available, but when the scaling action executes, the following error displays in AWS:

Cannot modify the instance class because there are no instances of the requested class available in the current instance's availability zone. Please try your request again at a later time.

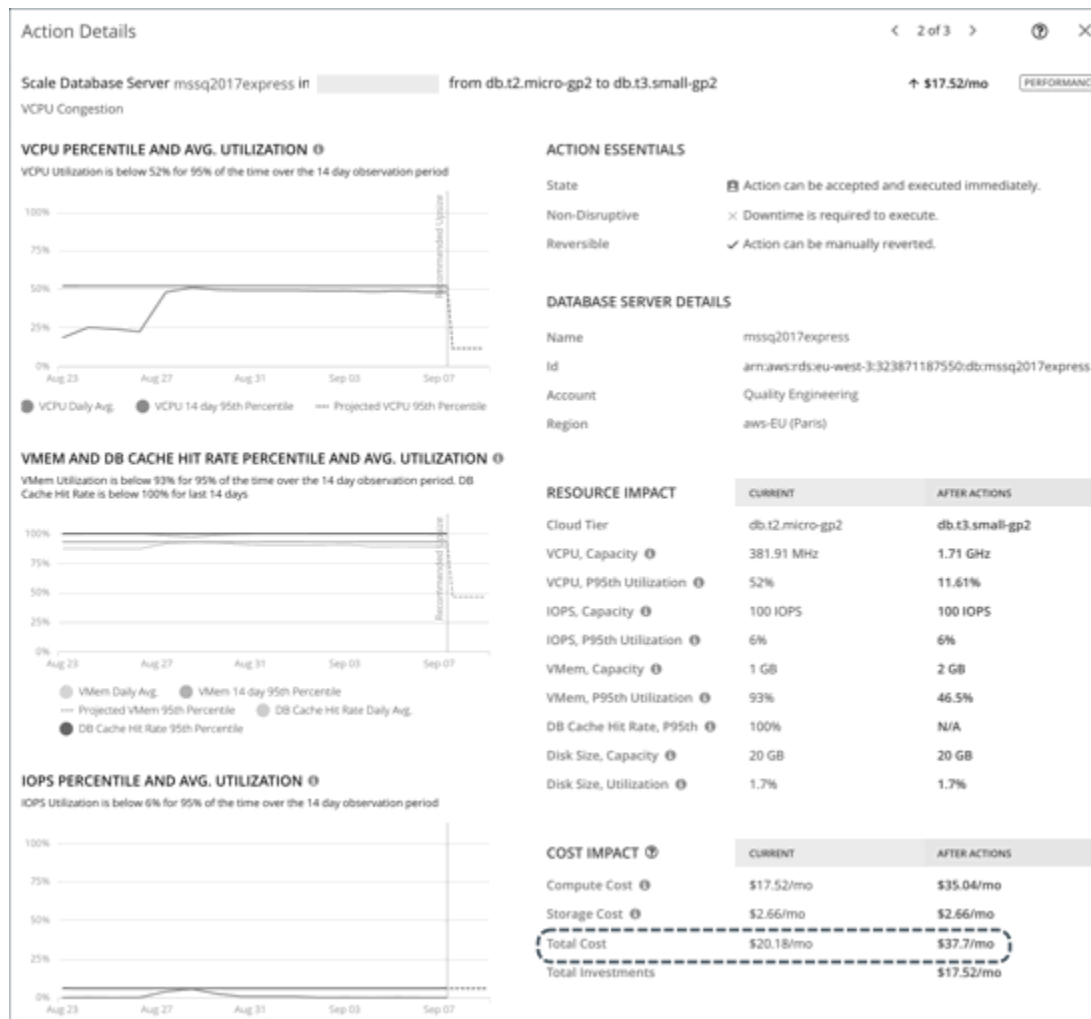
Note:

For details about this error, see this [AWS page](#).

When this error occurs, Turbonomic modifies the default Database Server policy to exclude the instance type from its scaling list. When the Database Server is available again, Turbonomic adds it back to the scaling list. For details about this list, see [Cloud Instance Types](#).

Estimated On-demand Costs for Cloud Database Servers

Turbonomic considers a variety of factors when calculating *Estimated On-demand Monthly Cost* for an AWS RDS Database Server.



Non-Aurora Database Servers

Cost Calculation

For non-Aurora Database Servers, the calculation for Estimated On-demand Monthly Cost can be expressed as follows:

$$(\text{On-demand Compute Rate} * 730) + (\text{Provisioned Database Storage Rate} * \text{Provisioned Database Storage Amount}) + (\text{Provisioned IOPS Rate} * \text{Provisioned IOPS Amount}) = \text{Estimated On-demand Monthly Cost}$$

Where:

- **On-demand Compute Rate** is the hourly cost for a Database Server's instance type

You can obtain on-demand rates via [Amazon RDS Pricing](#).

- **730** represents the number of hours per month that Turbonomic uses to estimate monthly costs.

- **Provisioned Database Storage Rate** is the hourly cost for a Database Server's provisioned database storage

You can obtain provisioned database storage rates via [Amazon RDS Pricing](#).

- **Provisioned IOPS Rate** is the monthly cost for a Database Server's provisioned IOPS

Provisioned IOPS apply only to Database Servers on Provisioned IOPS SSD (io1) storage. You can obtain information about Provisioned IOPS SSD storage via the [RDS User Guide](#).

You can obtain provisioned IOPS rates via [Amazon RDS Pricing](#).

The listed items above impact cost calculations and the scaling decisions that Turbonomic makes. These decisions also rely on other factors, such as resource utilization percentiles and scaling constraints set in policies.

Example

Assume the following data for a pending scale action for SQL Server Express Edition (Single A-Z deployment):

	Current Values	Values After Action Execution
On-demand Compute Rate	\$0.024/hr	\$0.048/hr
Provisioned Database Storage Rate	\$0.133/hr	\$0.133/hr
Provisioned Database Storage Amount	20 GB	20 GB
Provisioned IOPS Rate	\$0.00	\$0.00
Provisioned IOPS Amount	0	0

Turbonomic calculates the following:

- *Current* Estimated On-demand Monthly Cost:

$$(0.024 * 730) + (0.133 * 20) + (0.00 * 0) = 20.18$$

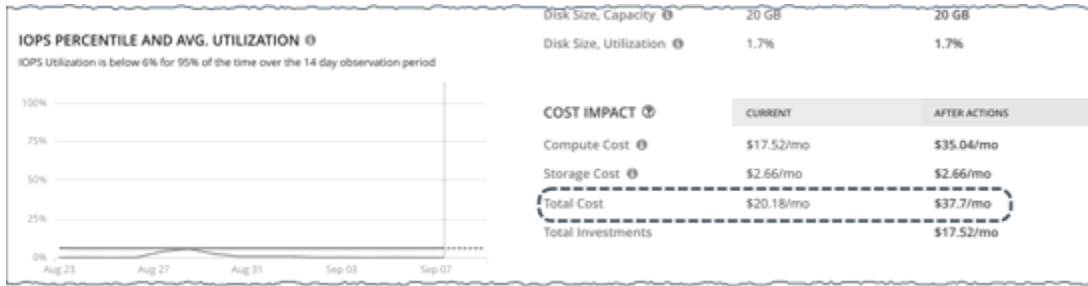
- Estimated On-demand Monthly Cost *after* executing the action:

$$(0.048 * 730) + (0.133 * 20) + (0.00 * 0) = 37.7$$

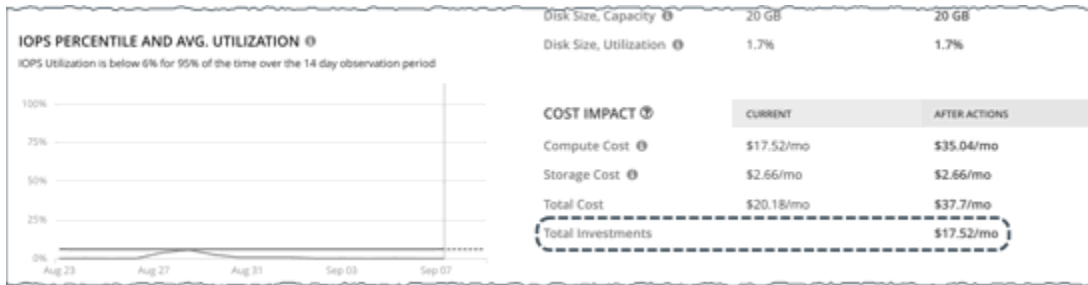
Note:

Turbonomic rounds the calculated values that it displays in the user interface.

The Estimated On-demand Monthly Cost is projected to increase from \$20.18/month to \$37.7/month, as shown in the Details section of the pending action.



Turbonomic treats the action as an investment and shows an estimated investment of \$17.52/month.



Aurora Database Servers

Cost Calculation

For Aurora Database Servers, the calculation for Estimated On-demand Monthly Cost can be expressed as follows:

$$(\text{On-demand Compute Rate} * 730) + (\text{Provisioned Database Storage Rate} * \text{Provisioned Database Storage Amount}) + (\text{I/O Request Rate} * (\text{Hourly Billed I/O Operation Count} * 730)) = \text{Estimated On-demand Monthly Cost}$$

Where:

- **On-demand Compute Rate** is the hourly cost for a Database Server's instance type
You can obtain on-demand rates via [Amazon Aurora Pricing](#).
- **730** represents the number of hours per month that Turbonomic uses to estimate monthly costs.
- **Provisioned Database Storage Rate** is the hourly cost for a Database Server's provisioned database storage
You can obtain provisioned database storage rates via [Amazon Aurora Pricing](#).
- **I/O Request Rate** is the cost per one million read/write I/O requests
You can obtain I/O request rates via [Amazon Aurora Pricing](#).
- **Hourly Billed I/O Operation Count** is the average sum of read and write I/O operations per hour over the last month

The listed items above impact cost calculations. Except for I/O request rate, these items affect the actual scaling decisions that Turbonomic makes. These decisions also rely on other factors, such as resource utilization percentiles and scaling constraints set in policies.

Example

Assume the following data for a pending scale action for Aurora MySQL-Compatible Edition:

	Current Values	Values After Action Execution
On-demand Compute Rate	\$0.164/hr	\$0.041/hr

	Current Values	Values After Action Execution
Provisioned Database Storage Rate	\$0.10/hr	\$0.10/hr
Provisioned Database Storage Amount	100	100
I/O Request Rate	\$0.20/one million requests	\$0.20/one million requests
Hourly Billed I/O Operation Count	2000	2000

Turbonomic calculates the following:

- *Current* Estimated On-demand Monthly Cost:

$$(0.164 * 730) + (0.10 * 100) + ((0.20 / 1000000) * (2000 * 730)) = 130.01$$

- Estimated On-demand Monthly Cost *after* executing the action:

$$(0.041 * 730) + (0.10 * 100) + ((0.20 / 1000000) * (2000 * 730)) = 40.22$$

Note:

Turbonomic rounds the calculated values that it displays in the user interface.

Since the Estimated On-demand Monthly Cost is projected to decrease from \$130.01/month to \$40.22/month, Turbonomic treats the action as a cost-saving measure and shows estimated savings of \$89.79/month.

Cloud Database Server Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about cloud Database Server actions, see [Cloud Database Server Actions](#) and [Non-disruptive and Reversible Scaling Actions](#).

Action	Default Setting/Mode
Database Server Scaling Actions	On
Disruptive irreversible scaling	Recommend
Disruptive reversible scaling	Recommend
Non-disruptive irreversible scaling	Recommend
Non-disruptive reversible scaling	Recommend

Scaling Sensitivity

Turbonomic uses a percentile of utilization over the specified observation period. This gives sustained utilization and ignores short-lived bursts.

Turbonomic uses these settings to calculate utilization percentiles for VCPU, VMEM and DB Cache Hit Rate, and IOPS. It then recommends actions to improve utilization based on the observed values for a given time period.

- **Aggressiveness**

Attribute	Default Value
Aggressiveness	95th Percentile

When evaluating performance, Turbonomic considers resource utilization as a percentage of capacity. The utilization drives actions to scale the available capacity either up or down. To measure utilization, the analysis considers a given utilization percentile. For example, assume a 95th percentile. The percentile utilization is the highest value that 95% of the observed samples fall below. Compare that to average utilization, which is the average of *all* the observed samples.

Using a percentile, Turbonomic can recommend more relevant actions. This is important in the cloud, so that analysis can better exploit the elasticity of the cloud. For scheduled policies, the more relevant actions will tend to remain viable when their execution is put off to a later time.

For example, consider decisions to reduce capacity. Without using a percentile, Turbonomic never resizes below the recognized peak utilization. Assume utilization peaked at 100% just once. Without the benefit of a percentile, Turbonomic will not reduce resources for that Database Server.

With **Aggressiveness**, instead of using the single highest utilization value, Turbonomic uses the percentile you set. For the above example, assume a single burst to 100%, but for 95% of the samples, utilization never exceeded 50%. If you set **Aggressiveness** to 95th Percentile, then Turbonomic can see this as an opportunity to reduce resource allocation.

In summary, a percentile evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, as follows:

- 99th Percentile – More performance. Recommended for critical Database Servers that need maximum guaranteed performance at all times, or those that need to tolerate sudden and previously unseen spikes in utilization, even though sustained utilization is low.
- 95th Percentile (Default) – The recommended setting to achieve maximum performance and savings. This assures performance while avoiding reactive peak sizing due to transient spikes, thus allowing you to take advantage of the elastic ability of the cloud.
- 90th Percentile – More efficiency. Recommended for Database Servers that can stand higher resource utilization.

By default, Turbonomic uses samples from the last 14 days. Use the **Max Observation Period** setting to adjust the number of days. To ensure that there are enough samples to analyze and drive scaling actions, set the **Min Observation Period**.

- **Max Observation Period**

Attribute	Default Value
Max Observation Period	Last 14 Days

To refine the calculation of resource utilization percentiles, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. If the Database Server has fewer days' data then it uses all of the stored historical data.

You can make the following settings:

- Less Elastic – Last 30 Days
- Recommended – Last 14 Days
- More Elastic – Last 7 Days or Last 3 Days

Turbonomic recommends an observation period of 14 days so it can recommend scaling actions more often. Since Database Server scaling is minimally disruptive, scaling often should not introduce any noticeable performance risks.

- **Min Observation Period**

Attribute	Default Value
Min Observation Period	None

This setting ensures historical data for a minimum number of days before Turbonomic will generate an action based on the percentile set in **Aggressiveness**. This ensures a minimum set of data points before it generates the action.

Especially for scheduled actions, it is important that resize calculations use enough historical data to generate actions that will remain viable even during a scheduled maintenance window. A maintenance window is usually set for "down" time, when utilization is low. If analysis uses enough historical data for an action, then the action is more likely to remain viable during the maintenance window.

- More Elastic – None
- Less Elastic – 1, 3, or 7 Days

Cloud Instance Types

By default, Turbonomic considers all instance types currently available for scaling when making scaling decisions for Database Servers. However, you may have set up your Database Servers to *only scale to* or *avoid* certain instance types to reduce complexity and cost, or meet demand. Use this setting to identify the instance types that Database Servers can scale to.

Note:

Turbonomic automatically discovers and enforces Database Server tier exclusions configured in your AWS environment. You do not need to configure these tier exclusions in policies. To see a list of tier exclusions that are currently enforced, set the scope to one or several Database Servers and click the **Policies** tab.

Attribute	Default Value
Cloud Instance Types	None

Click **Edit** to set your preferences. In the new page that displays, expand a **cloud tier** (a family of instance types, such as *db.m1*) to see individual instance types and the resources allocated to them.

Select your preferred instance types or cloud tiers, or clear the ones that you want to avoid. After you save your changes, the main page refreshes to reflect your selections.

Note:

This policy setting is not available in plans.

If you selected a cloud tier and the service provider deploys new instance types to that tier later, then those instance types will automatically be included in your policy. Be sure to review your policies periodically to see if new instance types have been added to a tier. If you do not want to scale to those instance types, update the affected policies.

Scaling Target Utilization

This is the target utilization as a percentage of capacity.

Attribute	Default Value
VCPU	70
VMEM	90
IOPS	70
Storage Amount	90

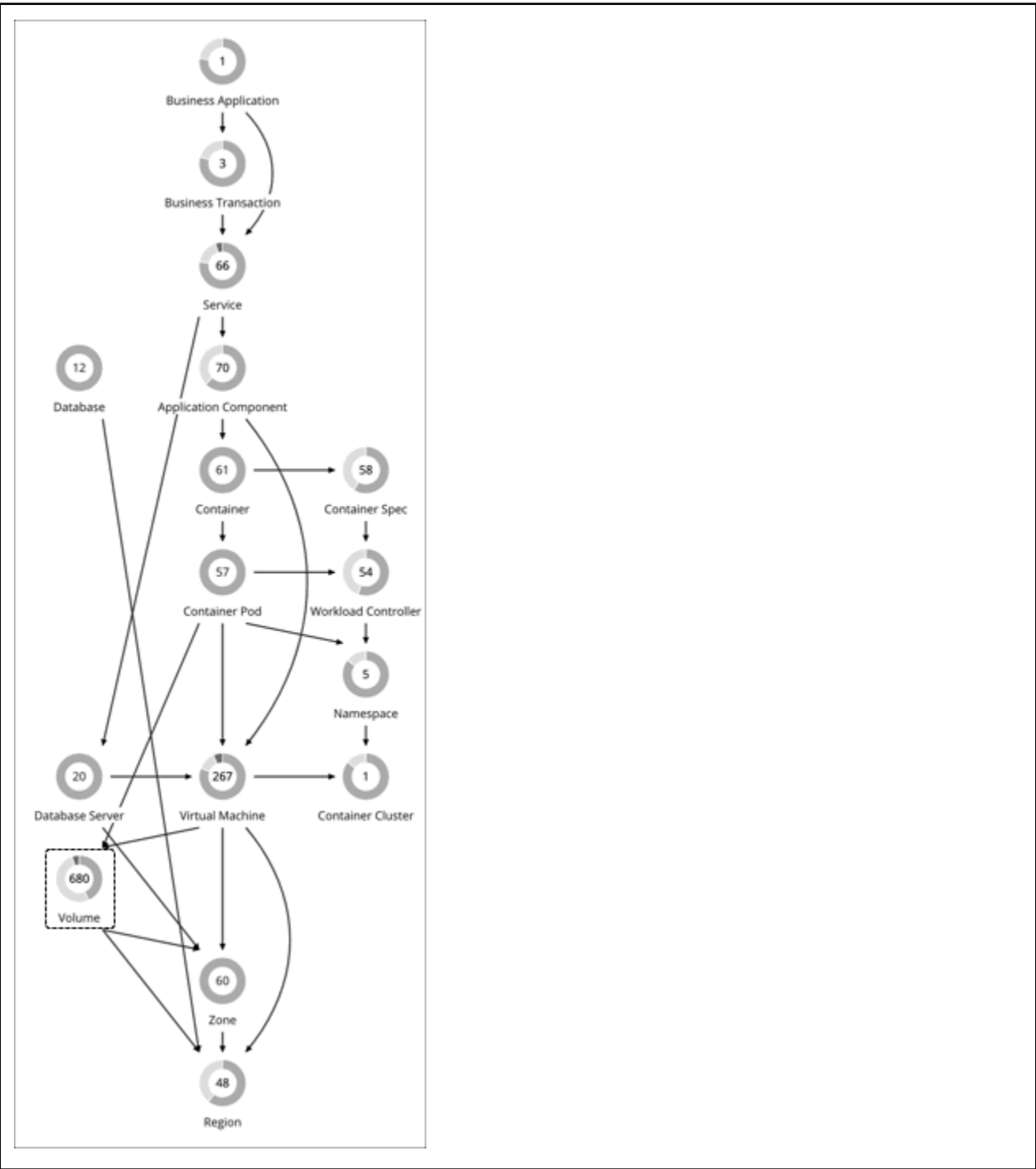
These advanced settings determine how much you would like a scope of workloads to utilize their resources. These are fixed settings that override the way Turbonomic calculates the optimal utilization of resources. You should only change these settings after consulting with Technical Support.

While these settings offer a way to modify how Turbonomic recommends actions, in most cases you should never need to use them. If you want to control how Turbonomic recommends actions to resize workloads, you can set the aggressiveness per the percentile of utilization, and set the length of the sample period for more or less elasticity on the cloud.

Volume (Cloud)

A cloud volume is a storage device that you can attach to a VM. You can use an attached volume the same as a physical hard drive.

Synopsis



Synopsis

Budget:	A cloud volume gains its budget by selling resources to the VMs that it serves.
Provides:	Storage resources for VMs to use: <ul style="list-style-type: none">• Storage Access• Storage Amount• IO Throughput

Synopsis	
Consumes:	Storage services provided by Zones or Regions
Discovered through:	AWS and Azure targets

Monitored Resources

Turbonomic monitors the following resources for a cloud volume:

- **Storage Access**
The percentage of the volume's capacity for storage access operations (measured in IOPS) that is in use.
- **IO Throughput**
The percentage of the volume's capacity for IO throughput (measured in MB/s) that is in use.
- **IO Throughput Read**
The percentage of the volume's capacity for IO throughput Read (measured in MB/s) that is in use.
- **IO Throughput Write**
The percentage of the volume's capacity for IO throughput Write (measured in MB/s) that is in use.

Note:

Turbonomic discovers Storage Amount (disk size) for AWS/Azure volumes, but does not monitor utilization.

For a Kubeturbo (container) deployment that includes AWS/Azure volumes, Kubeturbo monitors Storage Amount utilization for the volumes. You can view utilization information in the Capacity and Usage chart.

Actions

- **Scale**
Scale attached volumes to optimize performance and costs.
- **Delete**
Delete unattached volumes as a cost-saving measure.

Scale Actions

Scale attached volumes to optimize performance and costs. Turbonomic can recommend:

- Scaling within the same tier (scale up or down), or from one tier to another

Examples:

- An action to scale down IOPS for a high performance volume, such as Azure Managed Ultra
- An action to scale a volume from the *io1* to the *gp2* tier

These actions can reduce costs significantly while continuing to assure performance. In addition, they are *non-disruptive* and *reversible*.

Note:

For details about action disruptiveness and reversibility, see [Non-disruptive and Reversible Scaling Actions](#).

- Scaling from one tier to another and then within the new tier, in a single action

For example, to achieve higher IOPS performance for VMs that are premium storage capable, you might see an action to scale the corresponding volume from *Standard* to *Premium*, and then scale up volume

capacity from 32GB to 256 GB. This action increases costs and is *irreversible*, but is more cost effective than scaling up within the original tier.

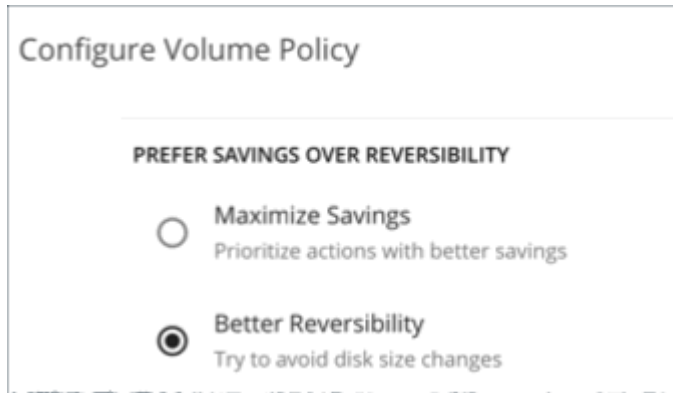
Note:

Not all VM types are premium storage capable. For details, see the [Azure Documentation](#).

When there are multiple disks attached to a volume, every volume scale action can potentially disrupt the same VM multiple times and some of the actions may fail due to concurrency. To mitigate these issues, Turbonomic identifies all volume actions associated with a particular VM and combines them into a single unit for execution, thus reducing disruptions and the chance of failures due to concurrency. This approach applies to scale actions in *Manual* or *Automated* mode.

You can create policies to control the scaling actions that Turbonomic generates.

- Turbonomic includes a policy setting that lets you choose between two outcomes – better savings (default) and better reversibility. If you choose reversibility, which can increase costs, Turbonomic will prioritize actions to change tiers whenever possible.



- Set scaling constraints if you want volumes to *only scale to* or *avoid* certain tiers. For details, see [Cloud Storage Tiers](#).

Delete Actions

Delete unattached volumes as a cost-saving measure.

If you delete an Azure volume and then later deploy a new one with an identical name, charts will include historical data from the volume that you deleted.

Exceptions for Azure Site Recovery and Azure Backup Volumes

Turbonomic discovers Azure Site Recovery and Azure Backup volumes when you add Azure targets. Even though these volumes are always unattached, Turbonomic will never recommend deleting them because they are critical to business continuity and disaster recovery.

To identify Azure Site Recovery volumes, Turbonomic checks an Azure resource called [Recovery Services vault](#), which includes information specific to the volumes. It also checks for the ASR-ReplicaDisk tag, which Azure automatically assigns to the volumes.

For Azure Backup volumes, Turbonomic checks for the RSVaultBackup tag.

It is important that you do not remove these tags. If these tags have been removed for some reason, create a volume policy for the affected volumes and disable the *Delete* action in that policy.

Action Execution for Locked Volumes

For Azure environments, Turbonomic can recommend scale and delete actions for [locked volumes](#), but the lock level configured for the volumes may prevent some actions from executing.

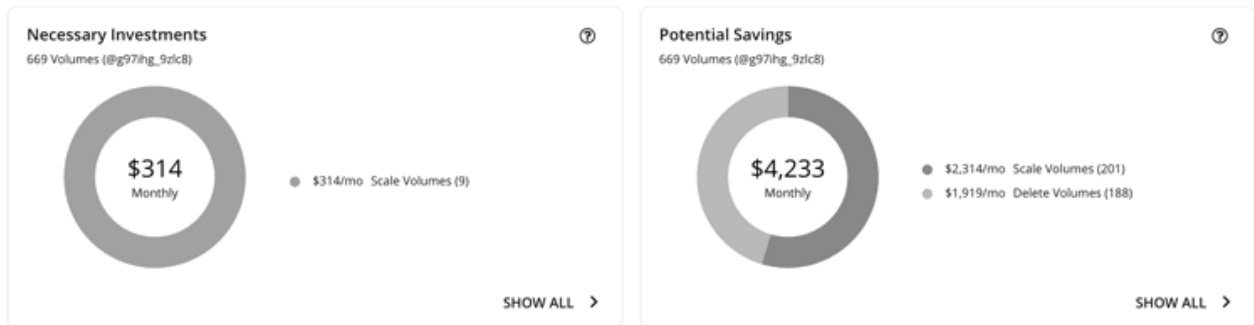
- For volumes with the ReadOnlY lock, both scale and delete actions are *not* executable.

- For volumes with the CanNotDelete lock, delete actions are *not* executable, but scale actions are executable.

You must sign in to Azure and then remove the locks for the affected volumes before you can execute actions. To identify the specific locks that you need to remove, open the Action Details page for a pending volume action and see the **Execution Prerequisites** section.

Volume Actions in Charts

Use the Necessary Investments and Potential Savings charts to view pending volume actions. These charts show total monthly investments and savings, assuming you execute all the actions.



Click **Show All** for each chart to review and execute the actions.

The table shows the following:

- Actions that are pending for each volume
- Savings or investments for each volume
- For *Delete* actions in the Potential Savings chart:

Potential Savings										
DELETE		AWS AZURE								
Volumes (191)		Delete Actions 189 Savings \$2,033/mo								
SCALE										
Volumes (157)										
		Volume ID	Subscription	Tier Type	Size	State	Days Unattached	Image Disk	Action Category	Savings
		<input type="checkbox"/>	aks-agentpool-3	Pay-As-You-Go - Prod	Managed Premium	30 GiB	Unattached	4	/Subscripti...	\$5.28/mo
		<input type="checkbox"/>	aks-agentpool-4	Pay-As-You-Go - Prod	Managed Premium	30 GiB	Unattached	4	/Subscripti...	\$5.28/mo
		<input type="checkbox"/>	aks-agentpool-8	Pay-As-You-Go - Prod	Managed Premium	30 GiB	Unattached	4	/Subscripti...	\$5.28/mo
		<input type="checkbox"/>	aks-agentpool-7	Pay-As-You-Go - Prod	Managed Premium	30 GiB	Unattached	4	/Subscripti...	\$5.28/mo

- Number of days a volume has been unattached

This information helps you decide whether to take the action.

Turbonomic polls your cloud volumes every 6 hours, and then records their state (attached or unattached) at the time of polling. It does not account for changes in state between polls. An unattached period of 1 day means that Turbonomic has discovered the volume as unattached in the last four polls.

Once Turbonomic discovers an unattached volume, it immediately recommends that you delete it. If a currently unattached volume is not deleted and is subsequently discovered as attached, Turbonomic removes the *Delete* action attached to it, and then resets the unattached period.

Note:

For volumes that have been deleted from the cloud provider and are no longer discoverable, Turbonomic removes them from its records after 15 days.

To see the last known VM attached to the volume, click **DETAILS**.

- For *Scale* actions in the Potential Savings or Necessary Investments chart:

Potential Savings

SCALE

Scale Actions 201 Savings \$2,314/mo

EXECUTE ACTIONS

Volumes (201)

☐

Volume Name

Account

Non-Disruptive

Reversible

Tier

Disk Size

IOPS

Cost

New Tier

Disk Size

New IOPS

New Cost

Action Category

Savings

Action

DELETE

Volumes (188)

☐

snap_image_dotn

Dev

Managed ...

1 TB

5000

\$149/mo

Managed ...

1 TB

500

\$41/mo

SAVINGS

↓ \$108/mo

DETAILS

☐

PTEricDisks2_Di

Prod

Managed ...

256 GB

1500

\$284/mo

Managed ...

256 GB

2143

\$180/mo

PERFORMANCE

↓ \$104/mo

DETAILS

☐

SQLServerDyna'

Dev

Managed ...

1 TB

5000

\$135/mo

Managed ...

1 TB

500

\$41/mo

SAVINGS

↓ \$94/mo

DETAILS

☐

SQLServerDyna'

Dev

Managed ...

1 TB

5000

\$135/mo

Managed ...

1 TB

500

\$41/mo

SAVINGS

↓ \$94/mo

DETAILS

☐

SQLServerTestV

Dev

Managed ...

1 TB

5000

\$135/mo

Managed ...

1 TB

500

\$41/mo

SAVINGS

↓ \$94/mo

DETAILS

☐

SQLServerTestV

Dev

Managed ...

1 TB

5000

\$135/mo

Managed ...

1 TB

500

\$41/mo

SAVINGS

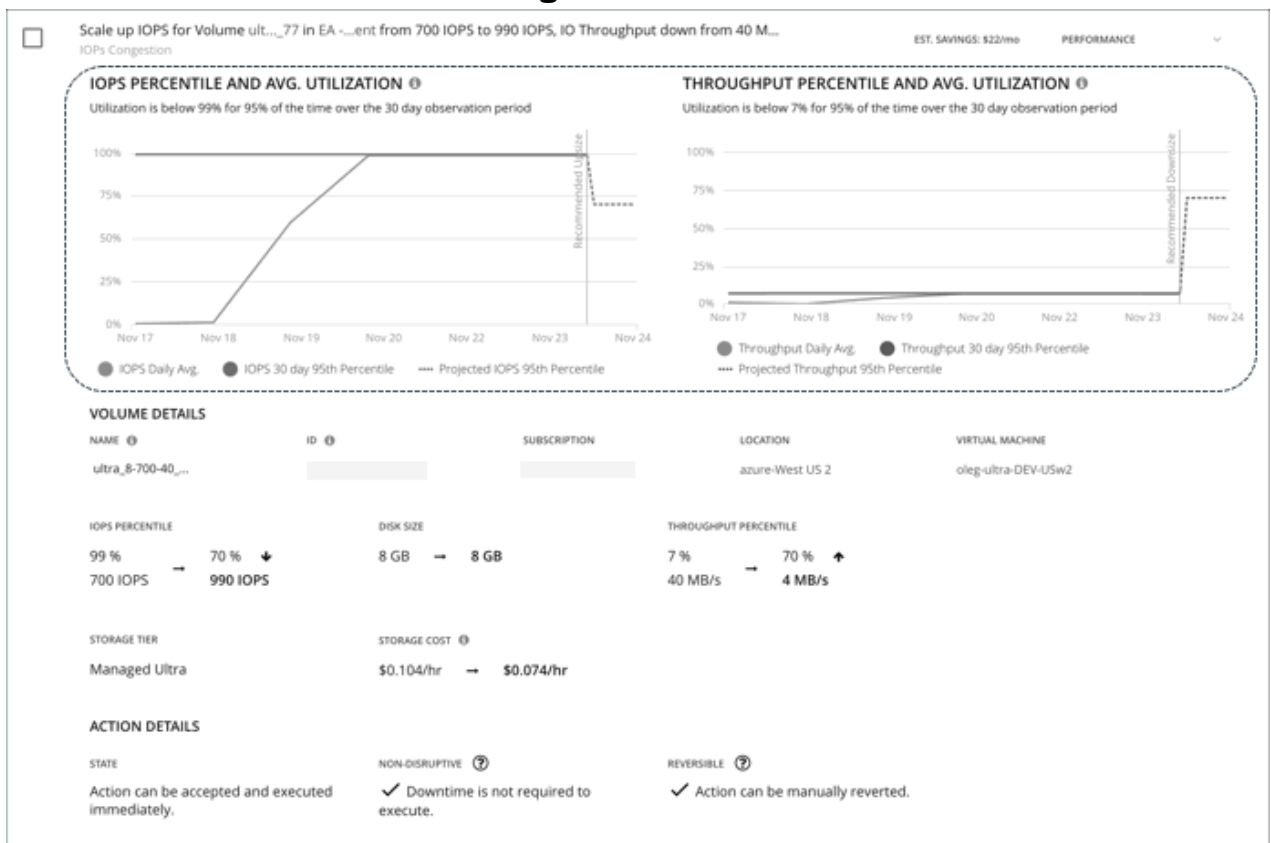
↓ \$94/mo

DETAILS

- Whether actions are non-disruptive or reversible
- Changes the actions will effect (for example, changes in tiers and/or resource allocations)

When you click the **DETAILS** button for a scaling action, you will see utilization charts that help explain the reason for the action.

Utilization Charts for Volume Scaling Actions



Turbonomic uses percentile calculations to measure IOPS and throughput more accurately, and drive scaling actions that improve overall utilization and reduce costs. When you examine the details for a pending scaling action on a volume, you will see charts that highlight resource *utilization percentiles* for a given observation period, and the projected percentiles after you execute the action.

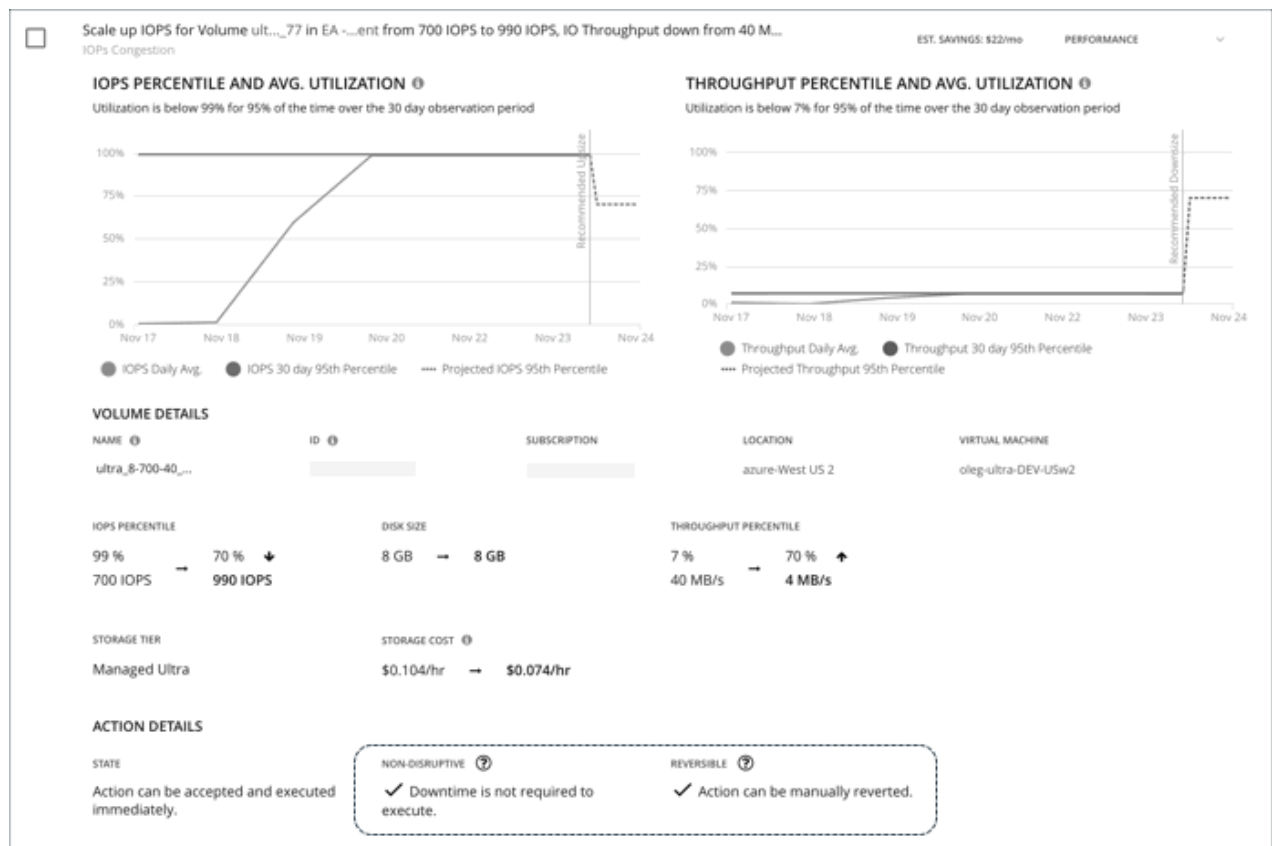
The charts also plot *daily average utilization* for your reference. If you have previously executed scaling actions on the volume, you can see the resulting improvements in daily average utilization. Put together, these charts allow you to easily recognize utilization trends that drive Turbonomic's scaling recommendations.

Note:

You can set scaling sensitivity in volume policies to refine the percentile calculations. For details, see [Scaling Sensitivity](#).

Non-disruptive and Reversible Scaling Actions

Turbonomic indicates whether a pending action is non-disruptive or reversible.



• Non-disruptive

Executing storage scaling actions can sometimes be disruptive if the VM must be rebooted to execute a storage change. For example, Azure Standard and Premium scaling actions are *disruptive*. When a storage action is disruptive, expect a single reboot (usually 2-3 minutes of downtime).

The following scaling actions are *non-disruptive*:

- Scaling IOPS and throughput on Azure Ultra storage
- All scaling actions on AWS storage

• Reversible

Executing storage scaling actions can sometimes be irreversible if the volume must grow in size to subsequently increase IOPS or throughput capacity. In this case, shrinking that volume's size later would not be possible. If you prefer reversible volume actions, create a volume policy and choose **Better Reversibility**.

Cloud Volume Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about cloud volume actions, see [Cloud Volume Actions](#).

Action	Default Mode
Scale	Manual
Delete	Manual

Prefer Savings Over Reversibility

Executing storage scaling actions can sometimes be irreversible if the volume must grow in size to subsequently increase IOPS or throughput capacity. In this case, shrinking that volume's size later would not be possible. If you prefer reversible volume actions, create a volume policy and choose **Better Reversibility**.

Scaling Sensitivity

Turbonomic uses a percentile of utilization over the specified observation period. This gives sustained utilization and ignores short-lived bursts.

• Aggressiveness

Attribute	Default Value
Aggressiveness	95th Percentile

Turbonomic uses Aggressiveness when evaluating IOPS and throughput.

When evaluating performance, Turbonomic considers resource utilization as a percentage of capacity. The utilization drives actions to scale the available capacity either up or down. To measure utilization, the analysis considers a given utilization percentile. For example, assume a 95th percentile. The percentile utilization is the highest value that 95% of the observed samples fall below. Compare that to average utilization, which is the average of *all* the observed samples.

Using a percentile, Turbonomic can recommend more relevant actions. This is important in the cloud, so that analysis can better exploit the elasticity of the cloud. For scheduled policies, the more relevant actions will tend to remain viable when their execution is put off to a later time.

For example, consider decisions to reduce capacity. Without using a percentile, Turbonomic never scales below the recognized peak utilization. Assume utilization peaked at 100% just once. Without the benefit of a percentile, Turbonomic will not reduce resources for that volume.

With **Aggressiveness**, instead of using the single highest utilization value, Turbonomic uses the percentile you set. For the above example, assume a single burst to 100%, but for 95% of the samples, utilization never exceeded 50%. If you set **Aggressiveness** to 95th Percentile, then Turbonomic can see this as an opportunity to reduce resource allocation.

In summary, a percentile evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, as follows:

- 99th or 100th Percentile – More performance. Recommended for critical volumes that need maximum guaranteed performance at all times, or those that need to tolerate sudden and previously unseen spikes in utilization, even though sustained utilization is low.
- 95th Percentile (Default) – The recommended setting to achieve maximum performance and savings. This assures performance while avoiding reactive peak sizing due to transient spikes, thus allowing you to take advantage of the elastic ability of the cloud.
- 90th Percentile – More efficiency. Recommended for volumes that can stand higher resource utilization.

By default, Turbonomic uses samples from the last 30 days. Use the **Max Observation Period** setting to adjust the number of days.

- **Max Observation Period**

Attribute	Default Value
Max Observation Period	Last 30 Days

To refine the calculation of resource utilization percentiles, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. If the volume has fewer days' data then it uses all of the stored historical data.

Choose from the following settings:

- Less Elastic – Last 90 Days
- Recommended – Last 30 Days
- More Elastic – Last 7 Days

- **Min Observation Period**

Attribute	Default Value
Min Observation Period	None

This setting ensures historical data for a minimum number of days before Turbonomic will generate an action based on the percentile set in **Aggressiveness**. This ensures a minimum set of data points before it generates the action.

Especially for scheduled actions, it is important that resize calculations use enough historical data to generate actions that will remain viable even during a scheduled maintenance window. A maintenance window is usually set for "down" time, when utilization is low. If analysis uses enough historical data for an action, then the action is more likely to remain viable during the maintenance window.

Choose from the following settings:

- More Elastic – None
- Less Elastic – 1, 3, or 7 Days

Scaling Target IOPS/Throughput Utilization

This is the target utilization as a percentage of capacity.

Attribute	Default Value
Scaling Target IOPS/Throughput Utilization	70

Cloud Storage Tiers

By default, Turbonomic considers all storage tiers currently available for scaling when making scaling decisions for volumes. However, you may have set up your cloud volumes to *only scale to* or *avoid* certain tiers to reduce complexity and cost, or meet demand. Use this setting to identify the tiers that volumes can scale to.

Attribute	Default Value
Cloud Storage Tiers	None

Click **Edit** to set your preferences. In the new page that displays, select your preferred cloud tiers or clear the ones that you want to avoid. After you save your changes, the main page refreshes to reflect your selections.

Database (Cloud)

Turbonomic discovers SQL Databases through your Azure targets. In particular, it discovers the resources on *individual databases* that are managed under both the DTU (Database Transaction Unit) and vCore pricing models.

- DTU Pricing Model

In the DTU model, Azure bundles CPU, memory, and IOPS as a single DTU metric. Turbonomic actions on these databases consider both DTU and storage utilization.

- vCore Pricing Model

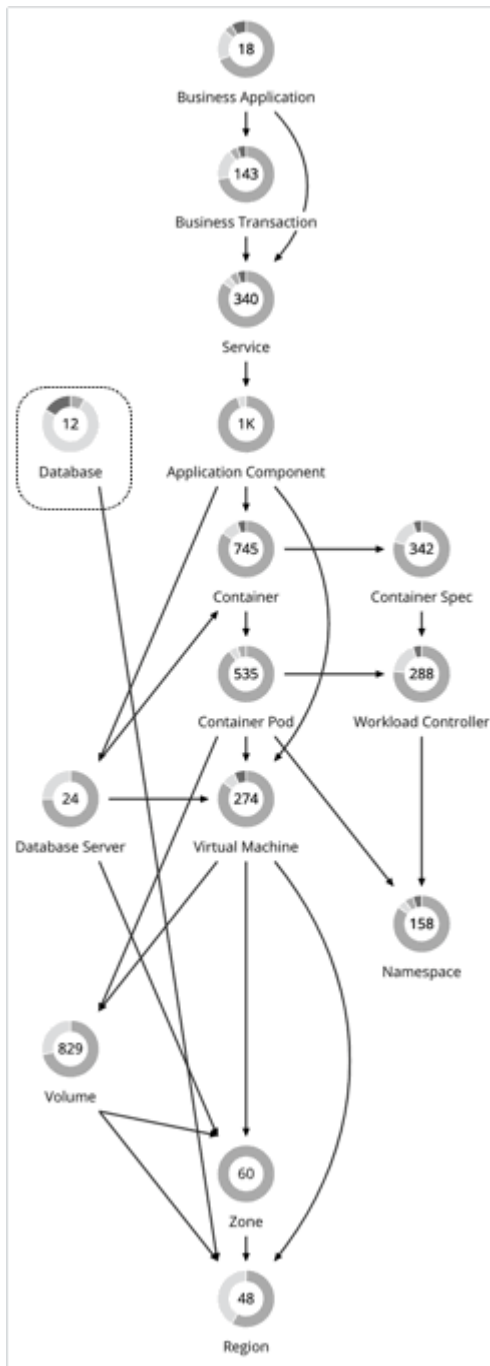
In the vCore model, analysis can track CPU, memory, IOPS, and throughput metrics in isolation. Turbonomic actions on these databases are driven by CPU, memory, IOPS, throughput and storage utilization.

Note:

For more information about the DTU and vCore models, see the [Azure documentation](#).

AWS RDS databases appear as *Database Server* entities in the supply chain. For details, see [Database Server \(Cloud\)](#).

Synopsis



Synopsis

Budget:	A database has unlimited budget.
Provides:	Transactions to end users
Consumes:	<ul style="list-style-type: none"> DTU Pricing Model: <ul style="list-style-type: none"> DTU and storage resources in an Azure region vCore Pricing Model: <ul style="list-style-type: none"> vCPU, vMem, IOPS, throughput, and storage resources in an Azure region

Synopsis

Discovered through:	Azure targets
---------------------	---------------

Actions analysis also considers levels of concurrent workers and concurrent sessions, to constrain instance type selection. In all cases, Turbonomic database scaling actions aim to increase resource utilization and reduce costs while complying with business policies.

Monitored Resources

The resources that Turbonomic can monitor depend on the pricing model in place for the given database entity.

- DTU Pricing Model
 - DTU
DTU capacity for the database. DTU represents CPU, memory, and IOPS/IO Throughput bundled as a single commodity.
 - Storage
Storage capacity for the database.
- vCore Pricing Model
 - Virtual Memory (VMem)
The utilization of VMem allocated to the Database instance
 - Virtual CPU (VCPU)
The utilization of VCPU allocated to the Database instance
 - Storage Access (IOPS)
The rate of input and output operations per second utilized by the Database instance
 - Throughput
The throughput utilization of transaction log write IO available to the Database instance
 - Storage
Storage capacity for the database.

Turbonomic drives scaling actions based on the utilization of these resources, and treats the following limits as constraints when it makes scaling decisions:

- Maximum concurrent sessions
Maximum number of database connections at a time.
- Maximum concurrent workers
Maximum number of database processes that can handle queries at a time.

Actions

Scale

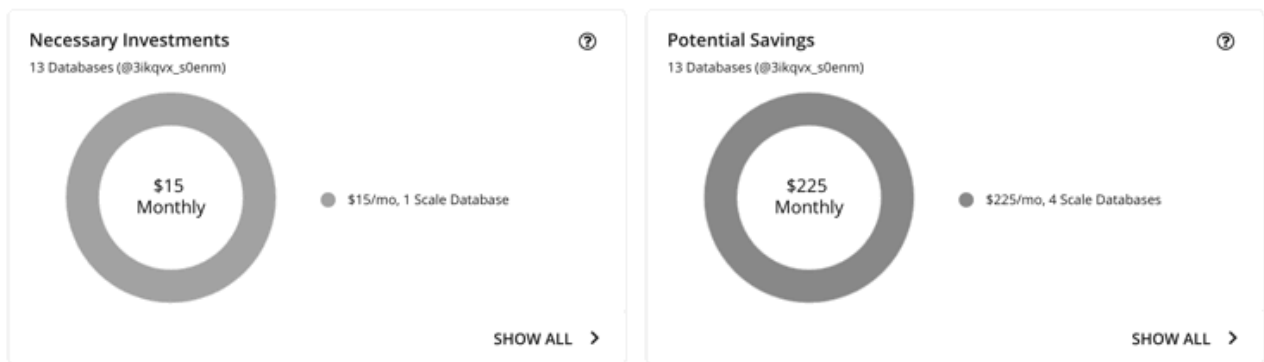
- DTU Model
Scale DTU and storage resources to optimize performance and costs.
- vCore Model
Scale vCPU, vMem, IOPS, throughput and storage resources to optimize performance and costs.

Points to consider:

- Turbonomic will *not* recommend:
 - Scaling from one pricing model to another
 - Scaling vCore databases to instance types running Gen4 hardware. This hardware generation is nearing end-of-life and pricing information can no longer be retrieved via the Azure API.
 - Scaling vCore databases on the [serverless compute tier](#)
 - Scaling provisioned memory for vCore databases on the Hyperscale service tier. VMem utilization data is currently unavailable for Hyperscale due to an issue in the Azure API.
- On DTU databases, a single action can scale both DTU and storage. On vCore databases, a single action can scale vCPU, vMem, IOPS, throughput, and storage.
- In some cases, Turbonomic might recommend scaling up storage, even if there is no storage pressure on the database, to take advantage of storage provided at no extra cost. For example, Turbonomic might recommend scaling from the *S3* to the *S0* tier because of low DTU and storage utilization. Since the *S0* tier includes 250 GB of storage at no extra cost, Turbonomic will also recommend scaling up to this storage amount. If you want to scale DTU but keep the storage amount unchanged, adjust the values for aggressiveness (percentile) and observation period in your database policies.

Actions in Charts

Use the Necessary Investments and Potential Savings charts to view pending database actions. These charts show total monthly investments and savings, assuming you execute all the actions.



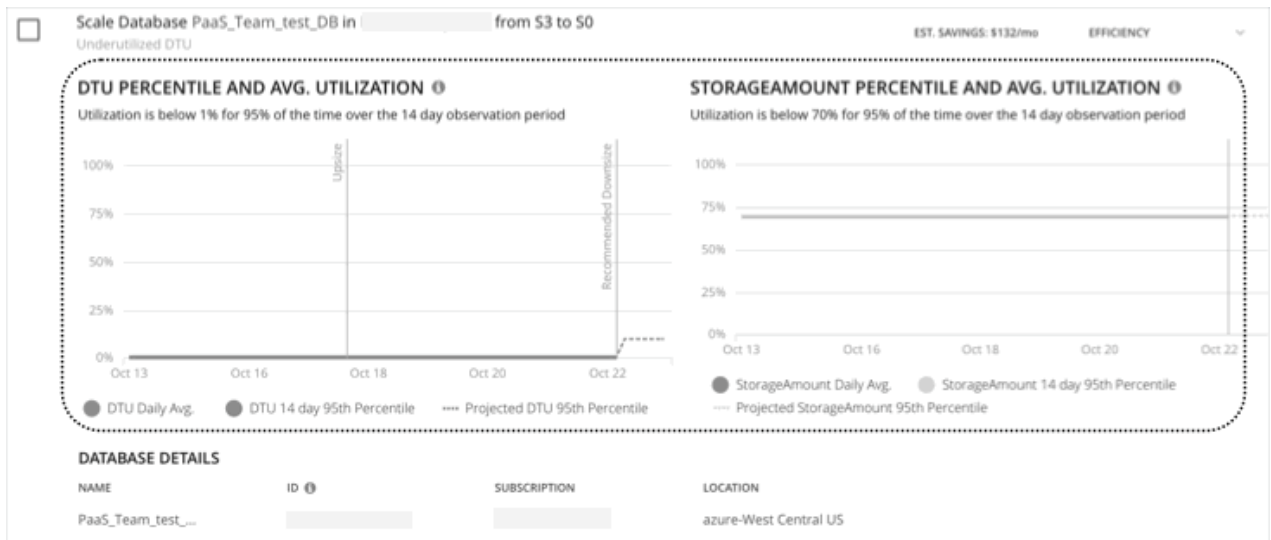
Click **Show All** for each chart to review and execute the actions.

The table shows the following:

- Actions that are pending for each database
- Savings or investments for each database

Utilization Charts for Scale Actions

Turbonomic uses percentile calculations to measure resource utilization, and drive scaling actions that improve overall utilization and reduce costs. When you examine the details for a pending scaling action on a database, you will see charts that highlight resource *utilization percentiles* for a given observation period, and the projected percentiles after you execute the action.



The charts also plot *daily average utilization* for your reference. If you have previously executed scaling actions on the database, you can see the resulting improvements in daily average utilization. Put together, these charts allow you to easily recognize utilization trends that drive Turbonomic's scaling recommendations.

Note:

You can set scaling constraints in database policies to refine the percentile calculations. For details, see [Aggressiveness and Observation Period](#).

Non-disruptive and Reversible Scaling Actions

All scaling actions shown in the Action Center view and Action Details page are non-disruptive and reversible.

For actions to scale vCore databases from General Purpose or Business Critical to Hyperscale, there are certain caveats associated with reversing such actions. To learn more, see the [Azure documentation](#).

Estimated On-demand Costs for Cloud Databases

Turbonomic considers a variety of factors when calculating *Estimated On-demand Monthly Cost* for an Azure SQL Database.

Database Server		
Pricing Model	DTU	
Tags	turbo_owner: turbo_comment: This is part of the test environment f... turbo_lifetime: 10	
RESOURCE IMPACT	CURRENT	AFTER ACTIONS
Cloud Tier	S3	S0
DTU, Capacity ⓘ	100	10
DTU, P95th Utilization ⓘ	1%	10%
Storage Amount, Capacity ⓘ	300 GB	250 GB
Storage Amount, P95th Utilization ⓘ	1%	1.2%
COST IMPACT ⓘ	CURRENT	AFTER ACTIONS
Compute Cost ⓘ	\$146.91/mo	\$14.69/mo
Storage Cost ⓘ	\$11.05/mo	\$0.00/mo
Total Cost	\$157.96/mo	\$14.69/mo
Total Savings		\$143.27/mo

Azure SQL DTU Databases

Cost Calculation

For Azure SQL DTU Databases, the calculation for Estimated On-demand Monthly Cost can be expressed as follows:

$$(\text{On-demand Compute Rate} \times 730) + (\text{Provisioned Database Storage Rate} \times (\text{Provisioned Database Storage Amount} - \text{Performance Level Included Storage})) = \text{Estimated On-demand Monthly Cost}$$

Where:

- **On-demand Compute Rate** is the **hourly** cost for a Database's instance type
You can obtain on-demand rates via [Azure SQL Database Pricing](#).
- **730** represents the number of hours per month that Turbonomic uses to estimate monthly costs.
- **Provisioned Database Storage Rate** is the cost for 1 GB / mo. of a Database's provisioned storage
You can obtain provisioned database storage rates via [Azure SQL Database Pricing](#).
- **Performance Level Included Storage** is the storage amount included in the price of the selected Performance Level of a DTU Database

You can obtain information on DTU storage limits via [DTU Storage Limits](#).

The listed items above impact cost calculations and the scaling decisions that Turbonomic makes. These decisions also rely on other factors, such as resource utilization percentiles and scaling constraints set in policies.

Example

Assume the following data for a pending scale action for an Azure SQL DTU Database:

	Current Values	Values After Action Execution
On-demand Compute Rate	\$0.20125/hr	\$0.020125/hr
Provisioned Database Storage Rate	\$0.221 per 1 GB/Mo.	\$0.221 per 1 GB/Mo.
Performance Level Included Storage	250 GB	250 GB
Provisioned Database Storage Amount	300 GB	250 GB

Turbonomic calculates the following:

- *Current* Estimated On-demand Monthly Cost:

$$(\$0.20125 * 730) + (\$0.221 * (300 - 250)) = \$157.96/\text{Mo.}$$

- Estimated On-demand Monthly Cost *after* executing the action:

$$(\$0.020125 * 730) + (\$0.221 * (250 - 250)) = \$14.69/\text{Mo.}$$

Note:

Turbonomic rounds the calculated values that it displays in the user interface.

The Estimated On-demand Monthly Cost is projected to decrease from \$157.96/month to \$14.69/month, as shown in the Details section of the pending action.

COST IMPACT ?	CURRENT	AFTER ACTIONS
Compute Cost ⓘ	\$146.91/mo	\$14.69/mo
Storage Cost ⓘ	\$11.05/mo	\$0.00/mo
Total Cost	\$157.96/mo	\$14.69/mo
Total Savings		\$143.27/mo

Turbonomic treats the action as a saving, and shows an estimated savings of \$143.27/month.

COST IMPACT ?	CURRENT	AFTER ACTIONS
Compute Cost ⓘ	\$146.91/mo	\$14.69/mo
Storage Cost ⓘ	\$11.05/mo	\$0.00/mo
Total Cost	\$157.96/mo	\$14.69/mo
Total Savings		\$143.27/mo

Azure SQL vCore Databases

Cost Calculation

For Azure SQL vCore Databases, the calculation for Estimated On-demand Monthly Cost can be expressed as follows:

$$(\text{On-demand Compute Rate} * 730) + (\text{SQL License Rate} * 730) + (\text{Provisioned Database Storage Rate} * (\text{Provisioned Database Storage Amount} + \text{Log Space Allocated})) = \text{Estimated On-demand Monthly Cost}$$

Where:

- **On-demand Compute Rate** is the hourly cost for a Database's instance type

You can obtain on-demand rates via [Azure SQL Database Pricing](#).

- **730** represents the number of hours per month that Turbonomic uses to estimate monthly costs.
- **SQL License Rate** is the hourly cost for a Database's SQL license

You can obtain SQL license rates via [Azure SQL Database Pricing](#).

Note: "Pay as you go" prices in the link above represent the sum of compute and license costs, while "Azure Hybrid Benefit Price" values represent compute costs only.

- **Provisioned Database Storage Rate** is the cost for 1 GB / mo. of a Database's provisioned storage

You can obtain provisioned database storage rates via [Azure SQL Database Pricing](#).

- **Log Space Allocated** is the log storage space automatically allocated to single Database instance by Azure.

Note: Log storage space is considered in database cost calculations, but not reflected in Storage capacity.

You can obtain provisioned database storage rates via [Azure SQL Database Pricing](#).

The listed items above impact cost calculations and the scaling decisions that Turbonomic makes. These decisions also rely on other factors, such as resource utilization percentiles and scaling constraints set in policies.

Example

Assume the following data for a pending scale action for an Azure SQL vCore Database:

	Current Values	Values After Action Execution
On-demand Compute Rate	\$1.068/hr	\$0.304/hr
SQL License Rate	\$0.799728/hr	\$0.199932/hr
Provisioned Database Storage Rate	\$0.115/hr	\$0.115/hr
Provisioned Database Storage Amount	32 GB	5 GB

Turbonomic calculates the following:

- *Current* Estimated On-demand Monthly Cost:

$$(\$1.068 * 730) + (\$0.799728 * 730) + (\$0.115 * (32 + 9.6)) = \$1368.23/\text{Mo.}$$

- Estimated On-demand Monthly Cost *after* executing the action:

$$(\$0.304 * 730) + (\$0.199932 * 730) + (\$0.115 * (5 + 1.5)) = \$368.62/\text{Mo.}$$

Note:

Turbonomic rounds the calculated values that it displays in the user interface.

Since the Estimated On-demand Monthly Cost is projected to decrease from \$1368.23/month to \$368.62/month, Turbonomic treats the action as a cost-saving measure and shows estimated savings of \$999.61/month.

Cloud Database Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about cloud database actions, see [Cloud Database Actions](#).

Action	Default Mode
Cloud DB Scale	Manual

Scaling Sensitivity

Turbonomic uses a percentile of utilization over the specified observation period. This gives sustained utilization and ignores short-lived bursts.

Turbonomic uses these settings to calculate utilization percentiles for DTU and storage. It then recommends actions to improve utilization based on the observed values for a given time period.

• Aggressiveness

Attribute	Default Value
Aggressiveness	95th Percentile

When evaluating performance, Turbonomic considers resource utilization as a percentage of capacity. The utilization drives actions to scale the available capacity either up or down. To measure utilization, the analysis considers a given utilization percentile. For example, assume a 95th percentile. The percentile utilization is the highest value that 95% of the observed samples fall below. Compare that to average utilization, which is the average of *all* the observed samples.

Using a percentile, Turbonomic can recommend more relevant actions. This is important in the cloud, so that analysis can better exploit the elasticity of the cloud. For scheduled policies, the more relevant actions will tend to remain viable when their execution is put off to a later time.

For example, consider decisions to reduce capacity. Without using a percentile, Turbonomic never resizes below the recognized peak utilization. Assume utilization peaked at 100% just once. Without the benefit of a percentile, Turbonomic will not reduce resources for that database.

With **Aggressiveness**, instead of using the single highest utilization value, Turbonomic uses the percentile you set. For the above example, assume a single burst to 100%, but for 95% of the samples, utilization never exceeded 50%. If you set **Aggressiveness** to 95th Percentile, then Turbonomic can see this as an opportunity to reduce resource allocation.

In summary, a percentile evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, as follows:

- 99th Percentile – More performance. Recommended for critical databases that need maximum guaranteed performance at all times, or those that need to tolerate sudden and previously unseen spikes in utilization, even though sustained utilization is low.

- 95th Percentile (Default) – The recommended setting to achieve maximum performance and savings. This assures performance while avoiding reactive peak sizing due to transient spikes, thus allowing you to take advantage of the elastic ability of the cloud.
- 90th Percentile – More efficiency. Recommended for databases that can stand higher resource utilization.

By default, Turbonomic uses samples from the last 14 days. Use the **Max Observation Period** setting to adjust the number of days.

- **Max Observation Period**

Attribute	Default Value
Max Observation Period	Last 14 Days

To refine the calculation of resource utilization percentiles, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. If the database has fewer days' data then it uses all of the stored historical data.

You can make the following settings:

- Less Elastic – Last 30 Days
- Recommended – Last 14 Days
- More Elastic – Last 7 Days or Last 3 Days

Turbonomic recommends an observation period of 14 days so it can recommend scaling actions more often. Since Azure SQL DB scaling is minimally disruptive, with near-zero downtime, scaling often should not introduce any noticeable performance risks.

Note:

For more information about Azure scaling downtimes, see the [Azure documentation](#).

- **Min Observation Period**

Attribute	Default Value
Min Observation Period	None

This setting ensures historical data for a minimum number of days before Turbonomic will generate an action based on the percentile set in **Aggressiveness**. This ensures a minimum set of data points before it generates the action.

Especially for scheduled actions, it is important that resize calculations use enough historical data to generate actions that will remain viable even during a scheduled maintenance window. A maintenance window is usually set for "down" time, when utilization is low. If analysis uses enough historical data for an action, then the action is more likely to remain viable during the maintenance window.

- More Elastic – None
- Less Elastic – 7 Days

Cloud Instance Types

By default, Turbonomic considers all instance types currently available for scaling when making scaling decisions for databases. However, you may have set up your cloud databases to *only scale to or avoid* certain instance types to reduce complexity and cost, or meet demand. Use this setting to identify the instance types that databases can scale to.

Attribute	Default Value
Cloud Instance Types	None

Click **Edit** to set your preferences. In the new page that displays, expand a **cloud tier** (a family of instance types, such as *Premium*) to see individual instance types and the resources allocated to them.

Select your preferred instance types or cloud tiers, or clear the ones that you want to avoid. After you save your changes, the main page refreshes to reflect your selections.

Note:

This policy setting is not available in plans.

If you selected a cloud tier and the service provider deploys new instance types to that tier later, then those instance types will automatically be included in your policy. Be sure to review your policies periodically to see if new instance types have been added to a tier. If you do not want to scale to those instance types, update the affected policies.

Scaling Target Utilization

The utilization that you set here specifies the percentage of the existing capacity that Turbonomic will consider to be 100% of capacity.

The settings you make depend on the pricing model in place for the workloads in the policy scope. To meet a target DTU utilization, the workloads must be members of a DTU pricing model. To meet individual VCPU, VMEM, or IOPs/Throughput targets, the workloads must be members of a vCore pricing model.

Attribute	DTU Pricing: Default Value	vCore Pricing: Default Value
Scaling Target DTU Utilization	70	N/A
VCPU	N/A	70
VMEM	N/A	90
IOPs/Throughput	N/A	70
Storage Amount Utilization	90	90

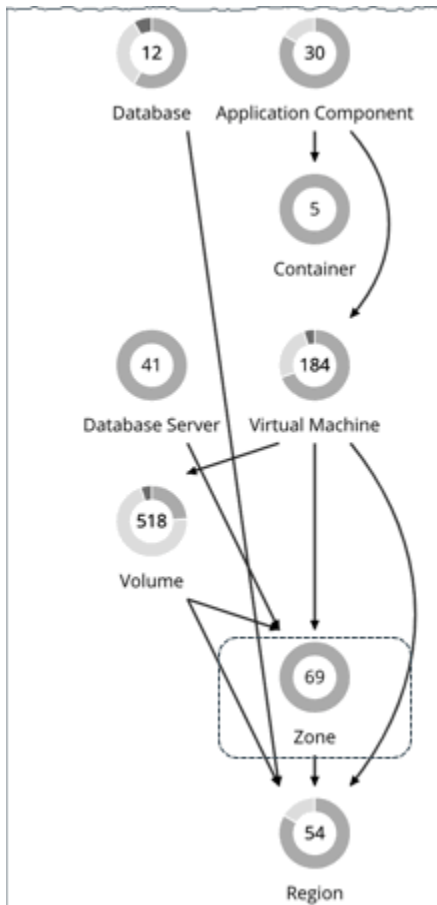
These advanced settings determine how much you would like a scope of workloads to utilize their resources. These are fixed settings that override the way Turbonomic calculates the optimal utilization of resources. You should only change these settings after consulting with Technical Support.

While these settings offer a way to modify how Turbonomic recommends actions, in most cases you should never need to use them. If you want to control how Turbonomic recommends actions to resize workloads, you can set the aggressiveness per the percentile of utilization, and set the length of the sample period for more or less elasticity on the cloud.

Zone

A Zone represents an Availability Zone in your public cloud account or subscription. A zone is a location within a given region that serves as a datacenter to host the workloads that you run in your environment.

Synopsis



Synopsis

Budget:	Turbonomic assumes a Zone has infinite resources.
Provides:	Compute and storage resources to VMs.
Consumes:	Region resources.
Discovered through:	Turbonomic discovers Zones through public cloud targets.

Monitored Resources

For public cloud environments, Turbonomic discovers the resources that an availability zone provides, including:

- Templates

The templates and template families that each zone or region delivers. This includes template capacity and cost for workload resources.

- Account Services

These include storage modes, services the accounts offer for enhanced metrics, and services for different storage capabilities.

- Relational Database Services (RDS)

The RDS capabilities each cloud account provides.

- Storage Tiers

Turbonomic discovers the storage tier that supports your workloads, and uses the tier pricing to calculate storage cost.

- Billing

Turbonomic discovers the billing across the zones and regions to predict costs in the future, and to track ongoing costs. This includes comparing on-demand pricing to Reserved Instance billing.

Turbonomic monitors the following resources for a Zone:

- Virtual Memory

The percentage utilized of memory capacity for all the workloads in the zone.

- Virtual CPU

The percentage utilized of VCPU capacity for all the workloads in the zone.

- Storage Access

For environments that measure storage access, the percentage utilized of access capacity for the zone.

- Storage Amount

The percentage utilized of storage capacity for the zone.

- IO Throughput

For environments that measure IO throughput, the percentage utilized of throughput capacity for the zone.

- IO Throughput Read

For environments that measure IO throughput read, the percentage utilized of throughput capacity for the zone.

- IO Throughput Write

For environments that measure IO throughput write, the percentage utilized of throughput capacity for the zone.

- Net Throughput

For environments that measure Net throughput, the percentage utilized of throughput capacity for the zone.

- Net Throughput Inbound

For environments that measure Net throughput Inbound, the percentage utilized of throughput inbound capacity for the zone.

- Net Throughput Outbound

For environments that measure Net throughput Outbound, the percentage utilized of throughput outbound capacity for the zone.

Actions

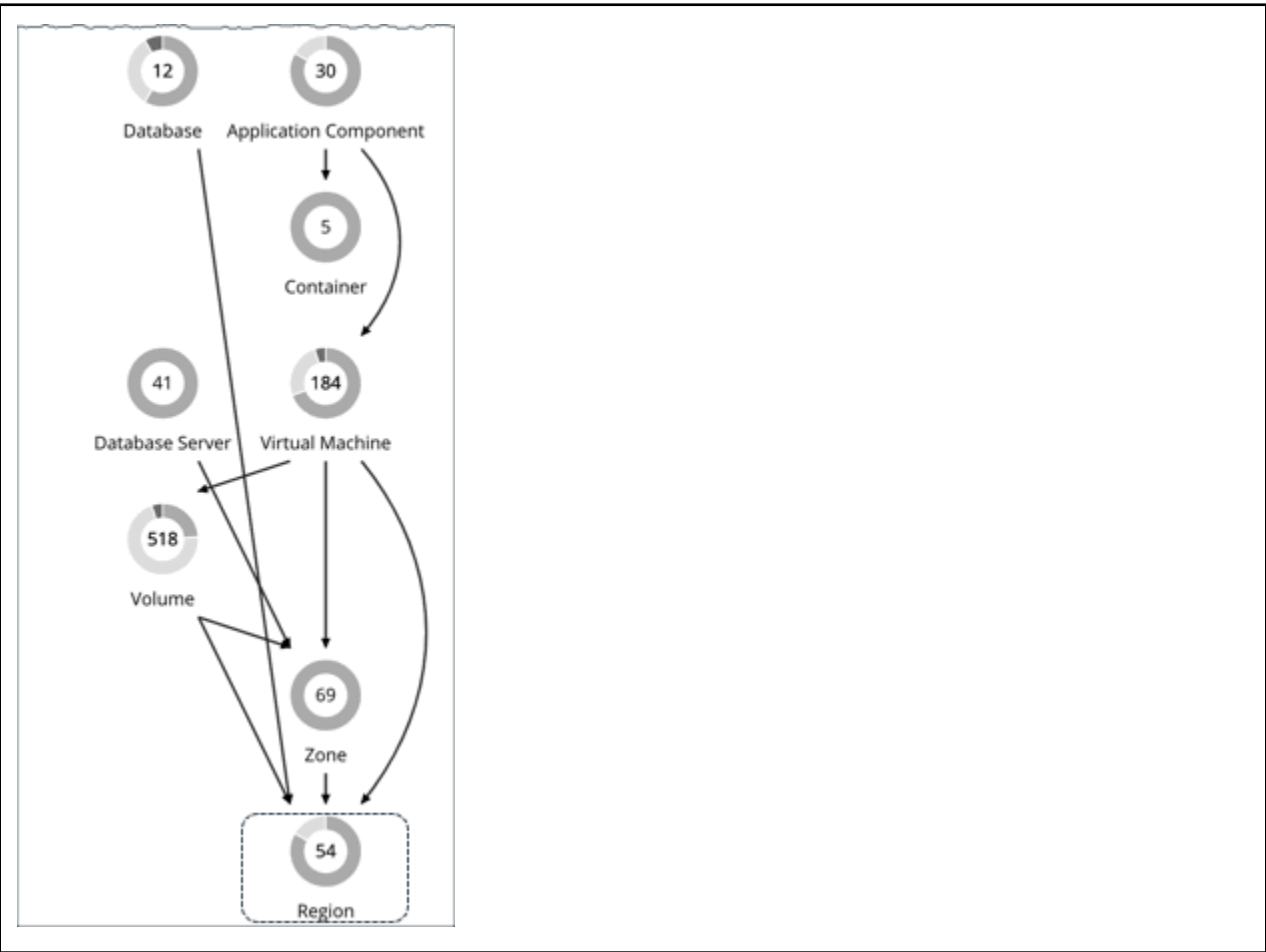
None

Turbonomic does not recommend actions for a cloud zone.

Region

A Region represents a geographical area that is home to one or more Availability Zones. Regions are often isolated from each other, and you can incur a cost for data transfer between them.

Synopsis



Synopsis	
Budget:	Turbonomic assumes a Region has infinite resources.
Provides:	Hosting and storage resources to Zones.
Consumes:	NA
Discovered through:	Cloud service accounts, such as accounts on Amazon AWS, or subscriptions on Microsoft Azure.

Monitored Resources

Turbonomic does not monitor resources directly from the region, but it does monitor the following resources, aggregated for the Zones in a region:

- Virtual Memory
The percentage utilized of memory capacity for workloads in the zones.
- Virtual CPU
The percentage utilized of VCPU capacity for workloads in the zones.
- Storage Access
For environments that measure storage access, the percentage utilized of access capacity for the zones.
- Storage Amount

The percentage utilized of storage capacity for the zones.

- IO Throughput

For environments that measure IO throughput, the percentage utilized of throughput capacity for the zones.

- IO Throughput Read

For environments that measure IO throughput read, the percentage utilized of throughput capacity for the zones.

- IO Throughput Write

For environments that measure IO throughput write, the percentage utilized of throughput capacity for the zones.

- Net Throughput

For environments that measure Net throughput, the percentage utilized of throughput capacity for the zones.

- Net Throughput Inbound

For environments that measure Net throughput Inbound, the percentage utilized of throughput inbound capacity for the zones.

- Net Throughput

For environments that measure Net throughput Outbound, the percentage utilized of throughput outbound capacity for the zones.

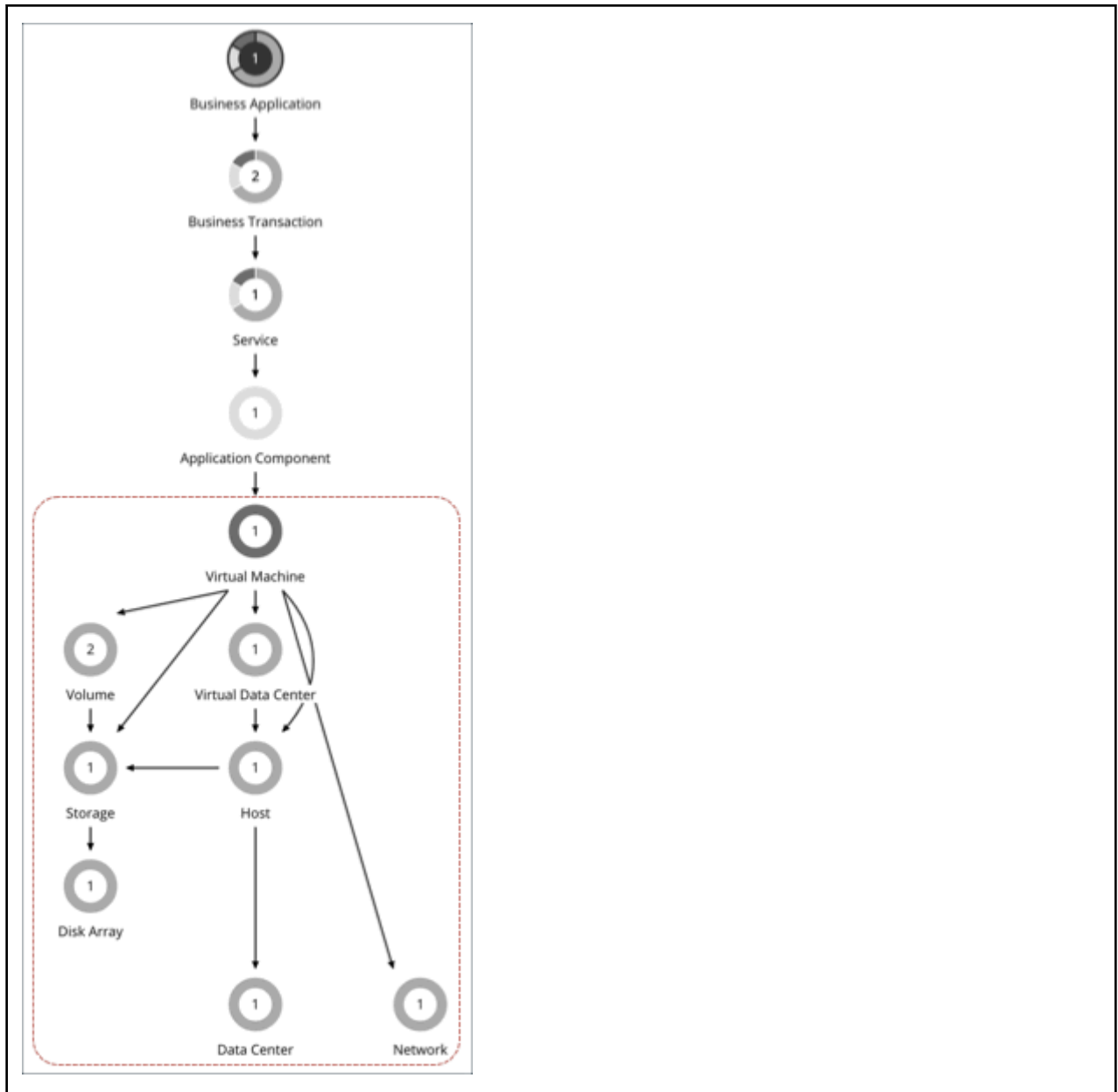
Actions

None

Turbonomic does not recommend actions for a cloud region.

Entity Types - On-prem Infrastructure

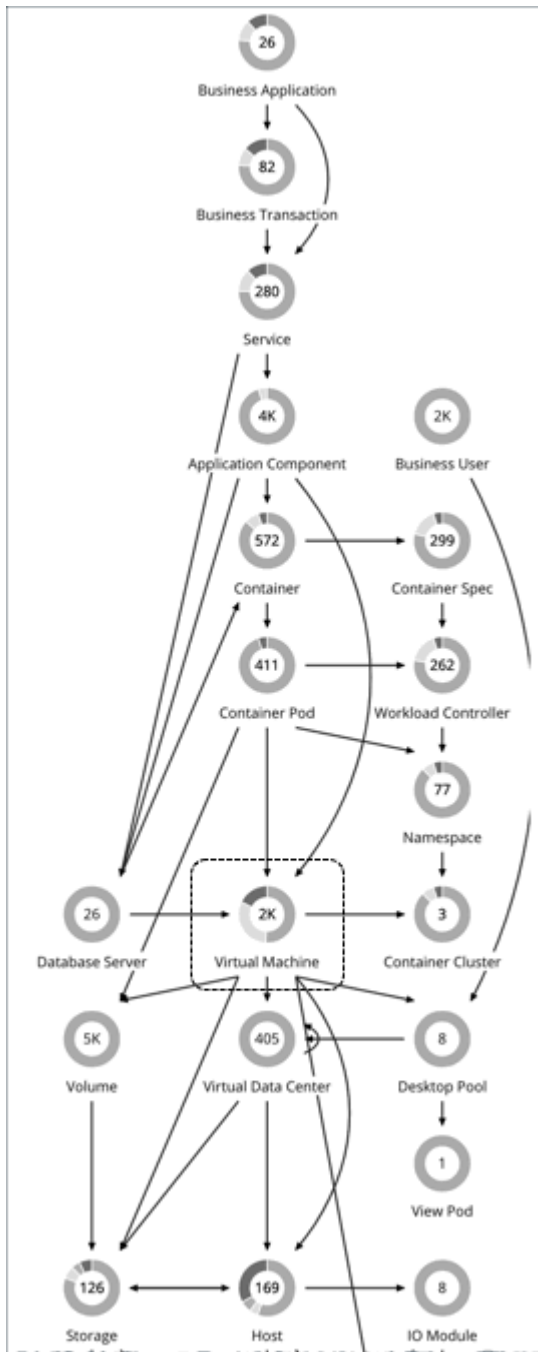
Turbonomic discovers and monitors the entities that make up your on-prem infrastructure, and recommends actions to assure performance for the applications that consume resources from these entities.



Virtual Machine (On-prem)

A virtual machine (VM) is a software emulation of a physical machine, including OS, virtual memory and CPUs, and network ports. VMs host applications, or they provide resources to container platforms.

Synopsis



Synopsis

Budget:

A VM gains its budget by selling resources to the applications it hosts. If utilization is high enough, Turbonomic can allocate more resources to the VM, provision another instance, or move the VM to a host that has more resources.

If utilization falls off, the VM loses budget. On the public cloud, if the budget isn't enough to pay for the host services, Turbonomic can post an action to suspend the VM.

Synopsis

Provides:	Resources for hosted applications to use: <ul style="list-style-type: none">• VMEM• VCPU• VStorage• IOPS (storage access operations per second)• Latency (capacity for disk latency in ms)• Memory and CPU Requests (for Kubernetes environments)
Consumes:	<ul style="list-style-type: none">• Physical host resources, including CPU and Mem• Storage
Discovered through:	Hypervisor targets

Monitored Resources

Turbonomic monitors the following resources for a VM:

- Virtual Memory (VMem)
The utilization of the VMem allocated to the hosting VM
- Virtual CPU (VCPU)
The utilization of the VCPU allocated to the hosting VM
- Virtual Storage (VStorage)
The utilization of the virtual storage capacity allocated for the VM
- Storage Access Operations Per Second (IOPS)
The utilization of IOPS allocated for the VStorage on the VM
- Latency
The utilization of latency allocated for the VStorage on the VM
Measured in milliseconds (ms)

For VMs that host Kubernetes pods:

- Memory Request Allocation
The memory available to the VM to support the ResourceQuota request parameter for a given VDC (Kubernetes namespace).
- CPU Request Allocation
The CPU available to the VM to support the ResourceQuota request parameter for a given VDC (Kubernetes namespace).
- Virtual Memory Request
The memory currently requested by containers. The capacity for this resource is the Node Allocatable capacity (the amount of resources available for pods).
- Virtual CPU Request
The CPU currently requested by containers. The capacity for this resource is the Node Allocatable capacity (the amount of resources available for pods).
- MemAllocation
The memory ResourceQuota limit parameter for a given VDC (Kubernetes namespace).

- CPUAllocation

The CPU ResourceQuota limit parameter for a given VDC (Kubernetes namespace).

Actions

• Resize

- Resize resource capacity

Change the capacity of a resource that is allocated for the VM. For example, a resize action might recommend increasing the VMem available to a VM. Before recommending this action, Turbonomic verifies that the VM's cluster can adequately support the new size. If the cluster is highly utilized, Turbonomic will recommend a move action, taking into consideration the capacity of the new cluster and compliance with existing placement policies.

For hypervisor targets, Turbonomic can resize vCPU by changing the VM's socket or cores per socket count. For details, see [VCPUs Scaling Controls](#).

- Resize resource reservation

Change the amount of a resource that is reserved for a VM. For example, a VM could have an excess amount of memory reserved. That can cause memory congestion on the host — A resize action might recommend reducing the amount reserved, freeing up that resource and reducing congestion

- Resize resource limit

Change the limit that is set on the VM for a resource. For example, a VM could have a memory limit set on it. If the VM is experiencing memory shortage, an action that decreases or removes the limit could improve performance on that VM.

• Move

Move a VM due to:

- High resource utilization on VM or host
- Excess IOPS or latency in VStorage
- Workload placement violation
- Underutilized host (move VM before suspending host)

• Move VM Storage (Volume)

Move a VM's volume due to excess utilization of the current datastore, or for more efficient utilization of datastores in the environment.

• Reconfigure

Change a VM's configuration to comply with a policy.

For hypervisor targets, Turbonomic can reconfigure VMs that violate vCPU scaling policies. For details, see [VCPUs Scaling Controls](#).

• Reconfigure VM Storage

Reconfigure overutilized storage resources by adding VStorage capacity. For underutilized storage resources, remove VStorage capacity.

Actions for Kubernetes Nodes (VMs)

Provision

Provision nodes to address workload congestion or meet application demand.

When recommending node provision actions, Turbonomic also recommends pod provision actions that reflect the projected demand from required DaemonSet pods, and respects the maximum number of pods allowed for a node. This ensures that any application workload can be placed on the new node and stay within the desired range of vMem/vCPU usage, vMem/vCPU request, and number of consumers.

The action details for a node provision action show the related DaemonSet pods that are required for the node to run. Click a pod name to set it at your scope.

Action Details

< 1 of 3 > ? X

Provision Virtual Machine similar to node1

VCPUs Congestion

PERFORMANCE

VIRTUAL MACHINE DETAILS

CONTAINER CLUSTER

Kubernetes-Turbonomic

TAGS

kubernetes.io/hostname: node1

kubernetes.io/arch: amd64

kubernetes.io/os: linux

storageclass: glusterfs

beta.kubernetes.io/arch: amd64

beta.kubernetes.io/os: linux

VIRTUAL CPU

20.7 GHz

VIRTUAL MEMORY

62.8 GiB

ACTION STATE

Action acceptance is blocked by policy or system. Acceptance mode is Recommend.

RELATED ACTIONS

CAUSING

Provision Container Pod similar to kube-system/calico-node-5cfzg

Provision Container Pod similar to default/glusterfs-gkdgx

Provision Container Pod similar to turbonomic/prometheus-node-exporter-hdfhk

Provision Container Pod similar to kube-system/nodelocaldns-2pcw6

Provision Container Pod similar to kube-system/kube-proxy-lkqj4

Suspend

Suspend nodes after you have consolidated pods or defragmented node resources to improve infrastructure efficiency.

When recommending node suspension actions, Turbonomic also recommends suspending the DaemonSet pods that are no longer required to run the suspended nodes.

The action details for a node suspension action show the related DaemonSet pods that are no longer needed to run the suspended nodes. Click a pod name to set it at your scope.

Entity Type	Resize Actions	Operational Constraints
	<ul style="list-style-type: none"> • VMEM Resize Up • VMEM Resize Down • VMEM Resize Above Max • VMEM Resize Below Min 	
Storage	<ul style="list-style-type: none"> • Storage Resize Up • Storage Resize Down • Storage Resize Above Max • Storage Resize Below Min 	<ul style="list-style-type: none"> • Storage Max Size • Storage Min Size

For example, assume the following settings:

Configure Virtual Machine Policy

AUTOMATION AND ORCHESTRATION
Defines how actions are accepted.

- VCPU Resize Up**
Automatic Acceptance
- VCPU Resize Down, VCPU Resize Above Max**
Manual Acceptance
- VCPU Resize Below Min**
Do not Generate Actions

ACTION CONSTRAINTS

OPERATIONAL CONSTRAINTS

- VCPU Resize Min Threshold (in Con): 2
- VCPU Resize Max Threshold (in Con): 8

With this policy in effect, Turbonomic will post the following actions:

- A VM with 6 VCPUs requests 2 new VCPUs: Automatic
- A VM with 8 VCPUs requests 2 new VCPUs: Manual
- A VM with 2 VCPUs requests to resize down to 1 VCPU: Disabled (Turbonomic does not post the action)

Action policies include scope to determine which entities will be affected by the given policy. It's possible for two or more policies to affect the same entities. As is true for other policy settings, tuned scaling uses the most conservative settings for the affected entities. The effective action mode will be the most conservative, and the effective tuned scaling range will be the narrowest range (the lowest MAX and

highest MIN) out of the multiple policies that affect the given entities. For more information, see [Policy Scope](#).

You can schedule automation policies to take effect during a certain window of time. You can include tuned scaling settings in a scheduled window, the same as you can schedule other policy settings. For more information, see [Policy Schedule](#).









On-prem VM Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about on-prem VM actions, see [On-prem VM Actions](#).

Action	Default Mode	vCenter	Hyper-V
vCPU Resize Down (uses tuned scaling)	Manual		
vMem Resize Down (uses tuned scaling)	Manual		
Move	Manual		
vMem Resize Above Max (uses tuned scaling)	Recommend		
Provision	Recommend		
vMem Resize Up (uses tuned scaling)	Manual		
vCPU Resize Below Min (uses tuned scaling)	Recommend		
vCPU Resize Above Max (uses tuned scaling)	Recommend		
Storage Move	Recommend		With VMM:  Otherwise: 
Start	Recommend		

Action	Default Mode	vCenter	Hyper-V
vMem Resize Below Min (uses tuned scaling)	Recommend		
Reconfigure (Change network and storage configurations)	Recommend		
vCPU Resize Up (uses tuned scaling)	Manual		
Suspend	Recommend		

You can use [Action Scripts](#) and third-party orchestrators (such as ServiceNow) for action orchestration.

Non-disruptive Mode

VM actions include the modifier, **Enforce Non Disruptive Mode**. When you enable this modifier, Turbonomic ensures that a resize action in *Automatic* or *Manual* mode will not require a reboot or any other disruption to the affected VM. If the action will disrupt the VM, Turbonomic posts the action in *Recommend* mode.

Attribute	Default Setting
Enforce Non-disruptive Mode	Off

This setting has no effect on actions set to *Recommend* mode. Turbonomic will continue to post those actions for you to evaluate.

You can enforce non disruptive mode in the default VM policy, and then schedule action policies to automate resize actions during downtimes. Be aware that scheduled actions do not respect the enforced non disruptive mode — Scheduled resize actions will execute during the scheduled window even if they require a reboot. This is useful for setting up certain action behaviors, but you must be aware that enforced non disruptive mode has no effect on scheduled actions.

Note:

When you configure a schedule window for a VM resize action, to ensure Turbonomic will execute the action during the scheduled time, you must turn off the **Enforce Non Disruptive Mode** setting for that scheduled policy. Even if you turn the setting off for the global policy, you still must turn the setting off for your scheduled policy. Otherwise Turbonomic will not execute the resize action.

Hypervisor VMEM for Resize

For on-prem environments, Turbonomic discovers VMEM utilization and can recommend actions to resize the VMEM capacity on a VM. For environments that do not include Applications and Databases as targets, the data that analysis uses to make these recommendations comes from the underlying hypervisors. However, that data is not always sufficient to result in accurate resize recommendations. Use the **Use Hypervisor VMEM for Resize** setting to determine how to generate VMEM recommendations.

Attribute	Default Setting
Hypervisor VMEM for Resize	On

- On

When your environment includes Applications and Databases as targets, Turbonomic uses the VMEM metrics those targets discover. If a scope of VMs does not fall under those targets, then analysis *will* generate VMEM resize actions for that scope. In this case, analysis uses the VMEM metrics it discovers from the underlying hypervisors.

- **Off**

When your environment includes Applications and Databases as targets, Turbonomic uses the VMEM metrics those targets discover. If a scope of VMs does not fall under those targets, then analysis *will not* generate VMEM resize actions for that scope.

Shared Nothing Migration

If you have enabled both storage and VM moves, Turbonomic can perform shared-nothing migrations, which move the VM and the stored VM files simultaneously. For example, assume a VM on a host also uses local storage on that host. In that case, Turbonomic can move that VM and move its data to a different datastore in a single action.

Attribute	Default Setting
Shared-nothing Migration	Off

Currently, the following targets support shared-nothing migrations:

- vSphere, versions 5.1 or greater
- VMM for Hyper-V 2012 or later

Because of this feature's potential impact on performance, it is turned off by default. Turbonomic recommends enabling it only on VMs that need it. To do this, you must first set the action mode for VM and storage moves to either *Manual* or *Automatic*, and then enable the feature in a VM policy.

If a policy that enables this feature conflicts with a more conservative policy, the latter policy wins. For example, if compute move is set to *Manual*, storage move is set to *Recommend*, and shared-nothing migration is turned on, shared-nothing migration is in effect but remains in *Recommended* state.

Note:

Turbonomic does not simulate shared-nothing migrations in plans.

Resize Thresholds (Operational Constraints)

Turbonomic uses these settings to set up tuned scaling actions for the VM. For an overview of tuned scaling, see [Tuned Scaling for On-prem VMs](#).

Attribute	Default Value
VCPU Resize Max Threshold (in Cores)	62 Tuned Scaling Range Upper Limit
VCPU Resize Min Threshold (in Cores)	2 Tuned Scaling Range Lower Limit
VMEM Resize Max Threshold (MB)	131072 Tuned Scaling Range Upper Limit
VMEM Resize Min Threshold (MB)	512 Tuned Scaling Range Lower Limit

Resize VStorage

The default setting disables resize actions. This is usually preferred because VStorage resize requires that you reformat the storage. The increment constant takes effect if you enable resizing.

Attribute	Default Setting/Value
Resize VStorage	Disabled
Increment constant for VStorage [GB]	None If you enable resize, Turbonomic uses the default value of 1024. You can change this to a different value.

vCPU Scaling Controls

For details, see [VCPU Scaling Controls](#).

Resize Increments

These increments specify how many units to add or subtract when resizing the given resource allocation for a VM.

Attribute	Default Value
Increment constant for VMEM [MB]	1024

Note:

Starting in version 8.5.7, vCPU resize increments are configured in conjunction with vCPU scaling controls. Any increment value configured in a previous version stays in effect and displays under **vCPU Scaling Controls > Change MHz legacy behavior**. For details, see [VCPU Scaling Controls](#).

For VMem, you should not set the increment value to be lower than what is necessary for the VM to operate. If the VMem increment is too low, then it's possible that Turbonomic would allocate insufficient VMem for the machine to operate. For a VM that is under utilized, Turbonomic will reduce VMem allocation by the increment amount, but it will not leave a VM with zero VMem. For example, if you set this to 1024, then Turbonomic cannot reduce the VMem to less than 1024 MB.

Rate of Resize

When resizing resources for a VM, Turbonomic calculates the optimal values for VMem, VCPU and VStorage. But it does not necessarily make a change to that value in one action. Turbonomic uses the Rate of Resize setting to determine how to make the change in a single action.

Attribute	Default Value
Rate of Resize	Medium (2)

- **Low**

Change the value by one increment, only. For example, if the resize action calls for increasing VMem, and the increment is set at 1024, Turbonomic increases VMem by 1024 MB.

- **Medium**

Change the value by an increment that is 1/4 of the difference between the current value and the optimal value. For example, if the current VMem is 2 GB and the optimal VMem is 10 GB, then Turbonomic will raise VMem to 4 GB (or as close to that as the increment constant will allow).

- **High**

Change the value to be the optimal value. For example, if the current VMem is 2 GB and the optimal VMem is 8 GB, then Turbonomic will raise VMem to 8 GB (or as close to that as the increment constant will allow).

Consistent Resizing

Attribute	Default Setting
Enable Consistent Resizing	Off

For groups in scoped policies:

When you create a policy for a group of VMs and turn on Consistent Resizing, Turbonomic resizes all the group members to the same size, such that they all support the top utilization of each resource commodity in the group. For example, assume VM A shows top utilization of CPU, and VM B shows top utilization of memory. A resize action would result in all the VMs with CPU capacity to satisfy VM A, and memory capacity to satisfy VM B.

Note:

For consistent resizing in on-prem environments, if the VMs in the group have different core speeds, then CPU scaling actions might not be consistent. For example, if you set the maximum target CPU size to 2, Turbonomic might recommend resizing to more than 2 CPUs to account for the VMs with slower cores.

To avoid this problem, be sure that the group only includes VMs with the same core speed.

For an affected resize, the Actions List shows individual resize actions for each of the VMs in the group. To avoid the possibility of resizing VMs disruptively at the same time, you must create automation policies with non-overlapping schedules. For example, if VMs A and B are in the same consistent resizing group, create two policies that resize the VMs at different times of the day.

- For Policy 1, set the scope to a group containing VM A and enable resize automation between, say, 01:00 and 01:45.

- For Policy 2 set the scope to a group containing VM B and enable resize automation between 02:00 and 02:45.

Reasons to employ Consistent Resizing for a group include:

- Load Balancing

If you have deployed load balancing for a group, then all the VMs in the group should experience similar utilization. In that case, if one VM needs to be resized, then it makes sense to resize them all consistently.

When working with Consistent Resizing, consider these points:

- You should not mix VMs in a group that has a Consistent Resizing policy, with other groups that enable Consistent Resizing. One VM can be a member of more than one group. If one VM (or more) in a group with Consistent Resizing is also in another group that has Consistent Resizing, then both groups enforce Consistent Resizing together, for all their group members.
- For any group of VMs that enables Consistent Resizing, you should not mix the associated target technologies. For example, one group should not include VMs that are on Hyper-V and vCenter platforms.
- Charts that show actions and risks assign the same risk statement to all the affected VMs. This can seem confusing. For example, assume one VM needs to resize to address vCPU risk, and 9 other VMs are set to resize consistently with it. Then charts will state that 10 VMs need to resize to address vCPU risks.

Ignore NVMe Constraints

Turbonomic recognizes when a VM instance includes an NVMe driver. To respect NVMe constraints, it will not recommend a move or resize to an instance type that does not also include an NVMe driver. If you ignore NVMe constraints, then Turbonomic is free to resize or move the instance to a type that does not include an NVMe driver.

Attribute	Default Setting
Ignore NVMe Constraints	Off

Placement Policies

Turbonomic supports placement policies for on-prem VMs, as follows:

- You can create placement policies to enforce constraints for VM placements.
For example, the VMs in a consumer group can only run on a host that is in the provider group. You can limit the number of consumers that can run on a single provider — for hosts in the provider group, only 2 instances of VMs in the consumer group can run on the same host. Or no more than the specified number of VMs can use the same storage device.
- For VMs that require paid licenses, you can create placement policies that set up certain hosts to be the VMs' preferred license providers. Turbonomic can then recommend consolidating VMs or reconfiguring hosts in response to changing demand for licenses.

For more information, see [Creating Placement Policies](#).

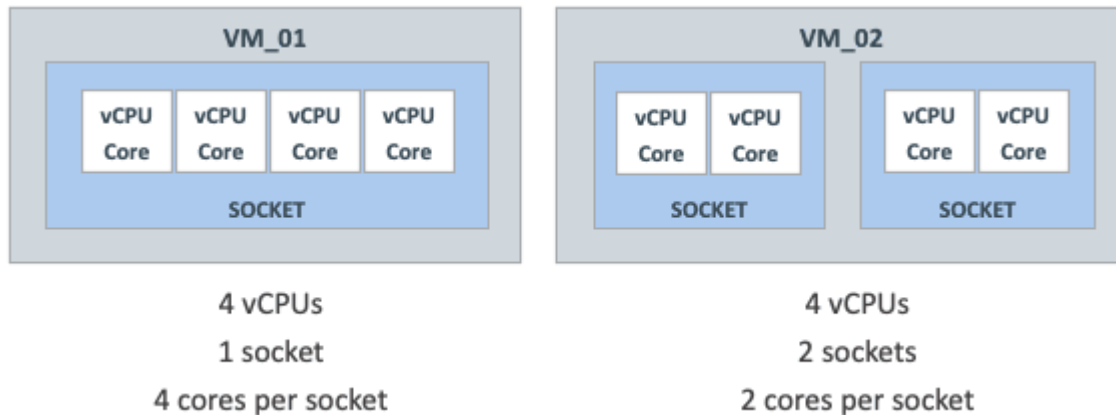
Note:

For VMM targets, IBM automatically imports your Availability Sets, representing them as placement policies for the affected infrastructure. To see these availability sets, go to the **Settings > Policies** page and click **Imported Placement Policies**.

For more information, see [Importing Workload Placement Policies](#).

vCPU Scaling Controls

Turbonomic represents the compute capacity of a VM in MHz and vCPUs. The following diagram shows how a VM with four vCPUs can be configured differently in terms of sockets and cores.



Turbonomic can resize the compute capacity by changing the number of sockets or cores per socket, depending on:

- The policy assigned to the VM

On-prem VM policies include vCPU Scaling Controls that give you granular control over how VM compute resources are *resized* to maintain performance or *reconfigured* to comply with your operational policies. You can create policies for different VM groups based on their resource needs and characteristics, and decide whether to automate resize and reconfigure actions in those policies.

- The hypervisor that manages the VM

Hypervisor targets have varying degrees of support for vCPU Scaling Controls. VMware vSphere supports all scaling controls, while Hyper-V and Nutanix AHV provide limited support. For details, see the *Hypervisor Support* section below.

vCPU Scaling Control Modes and Options

Turbonomic provides **simple** and **advanced** controls to automate compute resource management actions in compliance with your policies. It also provides a **legacy** control based on units of MHz.

The controls you choose depend on your operational policies regarding the VM configuration of sockets and cores per socket, and your choice of hypervisor. For example, your operational policies may dictate a certain VM configuration that must be respected when resizing a VM's compute resources. Changing sockets is the least disruptive, but for some workloads, it may be preferable to change cores per socket due to socket licensing or operating system constraints. For larger VMs where Non-Uniform Memory Access (NUMA) must be considered for performance reasons, it may be preferable to balance vCPUs across host sockets.

The following tables explain the exact operation for each mode.

Simple Controls

Simple controls change compute resources based on units of vCPU.

vCPU Scaling Option	Unit	Sockets	Cores Per Socket	Resize Action	Reconfigure Action
Change virtual CPUs	vCPUs	Turbonomic decides	Reconfigured to 1 core per socket	<ul style="list-style-type: none"> • Non-disruptive if hot-add is enabled and VM sockets are increasing • Disruptive if VM cores per socket does not equal 1, even if hot-add is enabled 	Disruptive

Advanced Controls

Advanced controls allow you to change sockets or cores per socket, and configure additional options.

vCPU Scaling Option	Unit	Sockets	Cores Per Socket	Resize Action	Reconfigure Action
Change sockets	1 socket	Turbonomic decides	Preserve VM cores per socket	Non-disruptive if hot-add is enabled and VM sockets are increasing	Not generated
Change sockets	1 socket	Turbonomic decides	User-specified VM cores per socket	<ul style="list-style-type: none"> • Non-disruptive if hot-add is enabled • Disruptive if VM cores per socket does not match user-specified value 	Disruptive if VM cores per socket does not match user-specified value
Change cores per socket	1 core per socket	Preserve VM sockets	Turbonomic decides	Disruptive	Not generated
Change cores per socket	1 core per socket	Match host sockets	Turbonomic decides	Disruptive	<ul style="list-style-type: none"> • Non-disruptive if hot-add is enabled and VM sockets are increasing • Disruptive if cores per socket is changed

vCPU Scaling Option	Unit	Sockets	Cores Per Socket	Resize Action	Reconfigure Action
Change cores per socket	1 core per socket	User-specified VM sockets	Turbonomic decides	Disruptive	<ul style="list-style-type: none"> • Non-disruptive if hot-add is enabled and VM sockets are increasing • Disruptive if cores per socket is changed

Legacy Controls

Legacy controls change compute resources based on units of MHz.

vCPU Scaling Option	Unit	Sockets	Cores Per Socket	Resize Action	Reconfigure Action
MHz legacy behavior	MHz	Turbonomic decides	<ul style="list-style-type: none"> • Assumes 1 core per socket • Execution preserves actual cores per socket 	Non-disruptive if hot-add is enabled and VM sockets are increasing	Not generated

Points to consider:

- If non-disruptive mode is enabled, disruptive actions are not automated and must be executed manually.
- Older Guest OSes and applications may be sensitive to changes in the vCPU architecture that could result in power-on issues or kernel panics/BSODs. Some workloads require manual help with such changes, so always test certain classes of applications and guest operating systems before enabling any automation that changes the vCPU architecture. Use the Turbonomic knowledge of the application domain and Guest OS to scope them out of policies.

Scaling Option: Change Virtual CPUs

In this scaling option, Turbonomic adds or removes compute resources in increments of vCPUs. To achieve this, it changes the number of VM sockets and enforces 1 core per socket (if not already enforced).

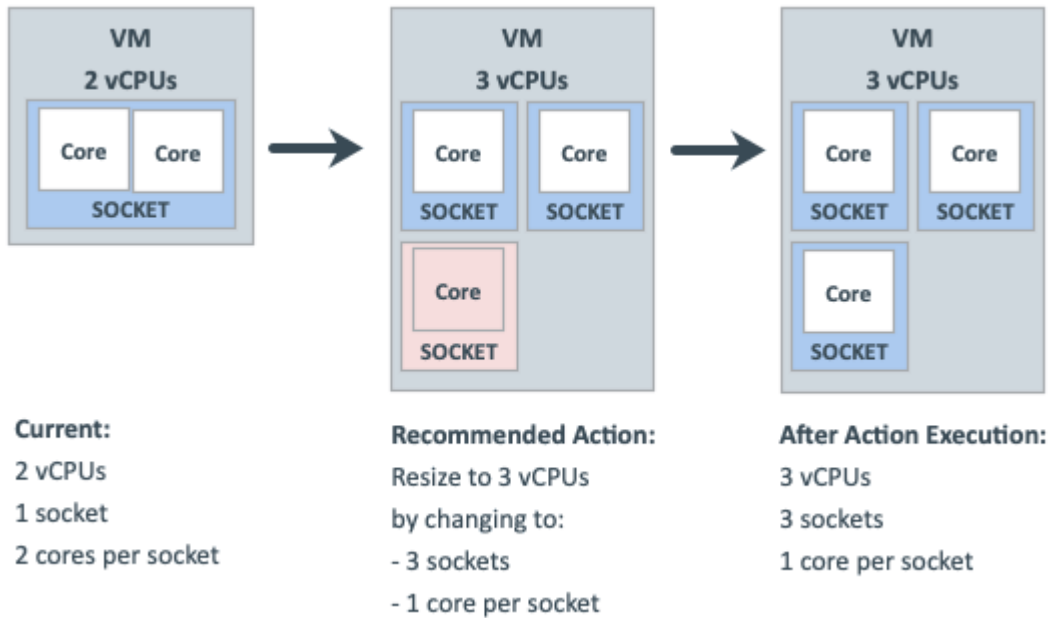
- If a VM requires a change to compute resources, Turbonomic generates a resize vCPU action that assumes 1 core per socket. If the VM currently does not have 1 core per socket, Turbonomic reconfigures it to 1 core per socket as part of action execution.
- If a VM is already optimally sized, but its current cores per socket is not 1, Turbonomic generates a reconfigure vCPU action to change cores per socket to 1, thereby bringing the VM into compliance with the policy.

This scaling option is ideal under the following scenarios:

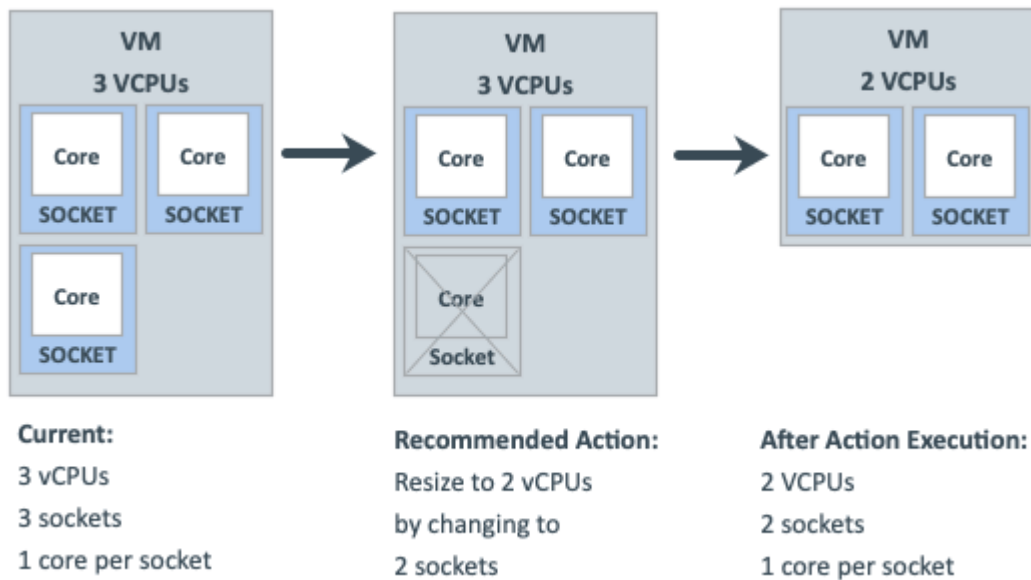
- Your environment has a large number of small VMs where precise vCPU scaling is the priority.
- You have VMs that already have 1 core per socket and require on-demand upsizes on these VMs to be non-disruptive.

For example, a VM currently has 1 socket and 2 cores per socket, and applies a policy that changes vCPU in increments of 1.

- If Turbonomic determines that the VM needs to increase compute capacity by 1 vCPU (i.e., from 2 to 3 vCPUs), a resize up action changes sockets from 2 to 3, and cores per socket from 2 to 1.



- When the same VM needs to reduce compute capacity by 1 vCPU (i.e., from 3 to 2 vCPUs), a resize down action changes sockets from 3 to 2.



Scaling Option: Change Sockets

In this scaling option, Turbonomic adds or removes compute resources by changing VM sockets.

- If a VM requires a change to compute resources, Turbonomic generates a resize vCPU action that considers the current cores per socket value (if the 'Preserve existing VM cores per socket' option is set) or uses the user-specified cores per socket value. If the VM's current cores per socket value violates a policy (i.e., does not match the user-specified value), Turbonomic reconfigures the VM's cores per

socket value as part of action execution, thereby bringing the VM into compliance with the policy, while at the same time providing the required change to compute resources.

- If a VM is already optimally sized, but its current cores per socket value violates a policy (i.e., does not match the user-specified value, if set), Turbonomic generates a reconfigure vCPU action to change cores per socket to the user-specified value, thereby bringing the VM into compliance with the policy.

Change Sockets and Preserve VM Cores Per Socket

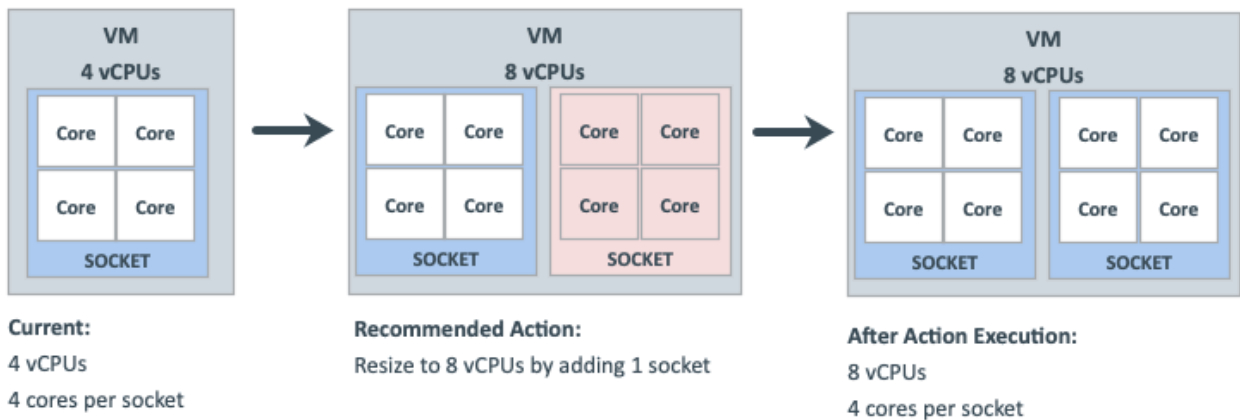
In this scaling option, Turbonomic adds or removes compute resources by changing VM sockets in increments of 1, and preserves VM cores per socket.

This scaling option is ideal under the following scenarios:

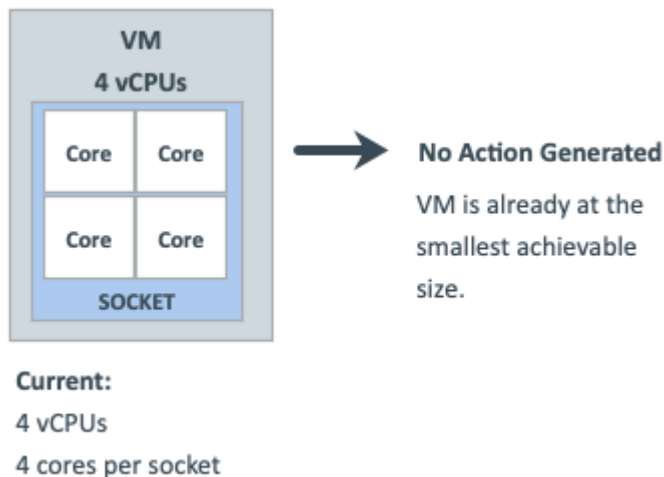
- You require Turbonomic to leave the VM cores per socket configuration unchanged for operational policy reasons (such as compliance with an application support contract policy).
- You have VMs that need to upsize non-disruptively to meet rising application demand.
- You have VMs with even numbers of cores per socket and are required to scale in even increments of vCPUs.

For example, a VM currently has 1 socket and 4 cores per socket, and applies a policy that changes sockets and preserves VM cores per socket. Turbonomic has determined that the VM requires a change in compute capacity of 1 vCPU.

- To increase compute capacity by 1 vCPU, a resize up action adds 1 socket. Because this new socket must have 4 cores to preserve VM cores per socket, the end result is 2 sockets with a total of 8 vCPUs.



- It is not possible to reduce compute capacity by 1 vCPU because the VM is already at the smallest achievable size. Therefore, no action generates.



Change Sockets and Specify Cores Per Socket

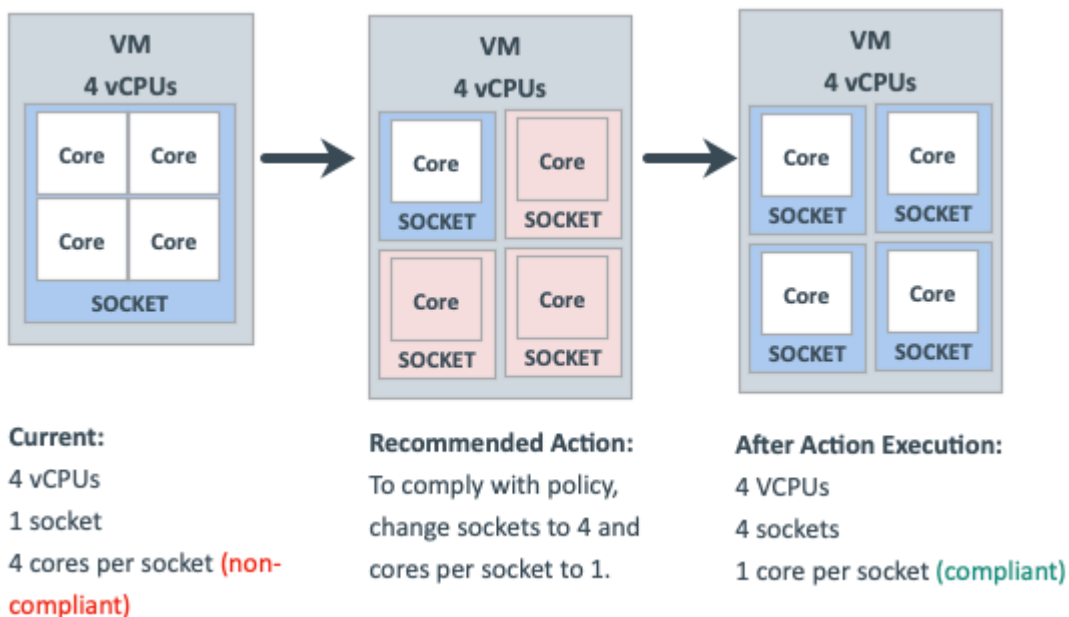
In this scaling option, Turbonomic adds or removes compute resources by changing VM sockets in increments of 1, and reconfigures VM cores per socket according to the value that you specify.

This scaling option is ideal under the following scenarios:

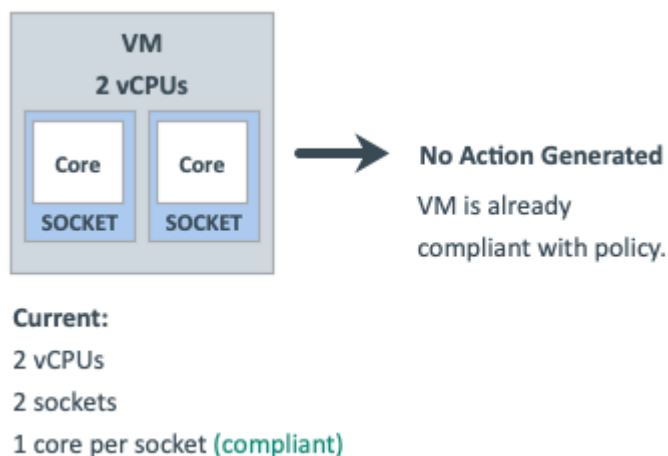
- You require any odd number vCPUs for a VM to be an even number, by setting an even number of cores per socket.
- You want a quick, script-less bulk disruptive conversion of VMs to a specific cores per socket without negatively impacting compute capacity (vCPUs).
- You have older Guest OSes and applications that are sensitive to vCPU architecture changes that could result in power-on issues or kernel panics/BSODs. Some workloads require manual help with such changes so always test certain classes of applications and OSes before enabling any automation that changes the vCPU architecture. Use the Turbonomic knowledge of the application domain and Guest OS to scope them out of policies.

For example, a VM currently has 1 socket and 4 cores per socket, and applies a policy that changes sockets and enforces the user-specified 1 core per socket. Turbonomic has determined that the VM is already optimally sized, so a resize action is not necessary.

- Since the VM is in violation of policy, Turbonomic changes sockets from 1 to 4, and cores per socket from 4 to 1.



- When the VM is compliant with policy, no action generates.



Scaling Option: Change Cores Per Socket

In this scaling option, Turbonomic adds or removes compute resources by changing the VM cores per socket.

- If a VM requires a change to compute resources, Turbonomic generates a resize vCPU action that considers the current socket value (if the 'Preserve existing VM sockets' option is set), respects the user-specified socket value, or matches VM sockets to the host socket value. If the VM's current socket value violates a policy (i.e., does not match the user-specified or host socket value), Turbonomic reconfigures the VM's socket value as part of action execution, thereby bringing the VM into compliance with the policy while at the same time providing the required change to compute resources.
- If a VM is already optimally sized, but its current socket value violates a policy, Turbonomic generates a reconfigure vCPU action to change the sockets to the user-specified or host socket value, thereby bringing the VM into compliance with the policy.

Older Guest OSes and applications may be sensitive to vCPU architecture changes that could result in power-on issues or kernel panics/BSODs. Some workloads require manual help with such changes so always test certain classes of applications and OSes before enabling any automation that changes the vCPU architecture. Use the Turbonomic knowledge of the application domain and Guest OS to scope them out of policies.

Change Cores Per Socket and Preserve VM Sockets

In this scaling option, Turbonomic adds or removes compute resources by changing the VM cores per socket in increments of 1, and preserves VM sockets.

This scaling option is ideal under the following scenarios:

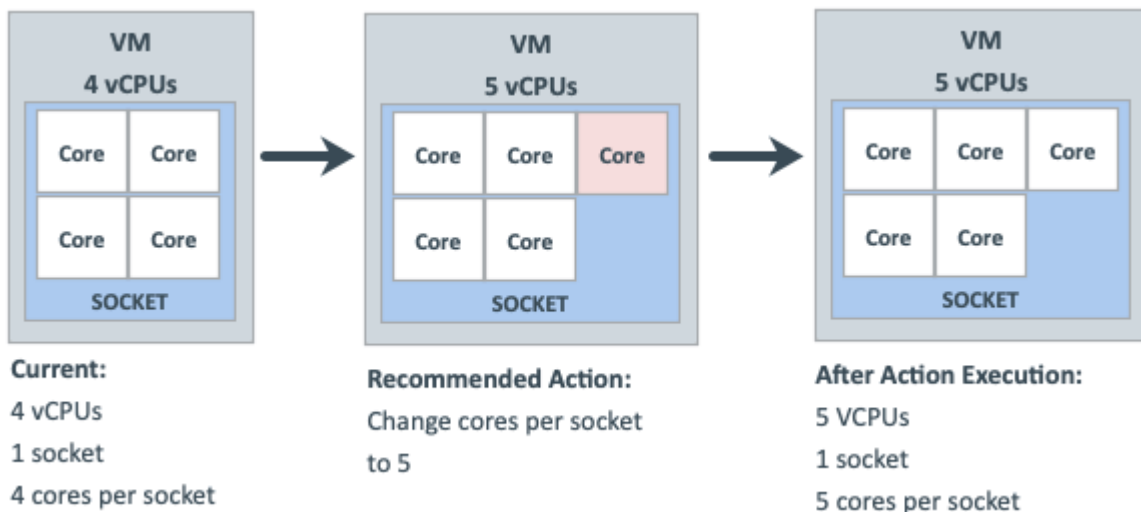
- You require Turbonomic to leave the VM sockets configuration unchanged for operational policy reasons (such as socket-based licensing or compliance with an application support contract policy).
- You have VDI VMs that are at their maximum Guest OS socket limitation, but require more compute resources.
- You have VMs that are configured with NUMA considerations.

Note:

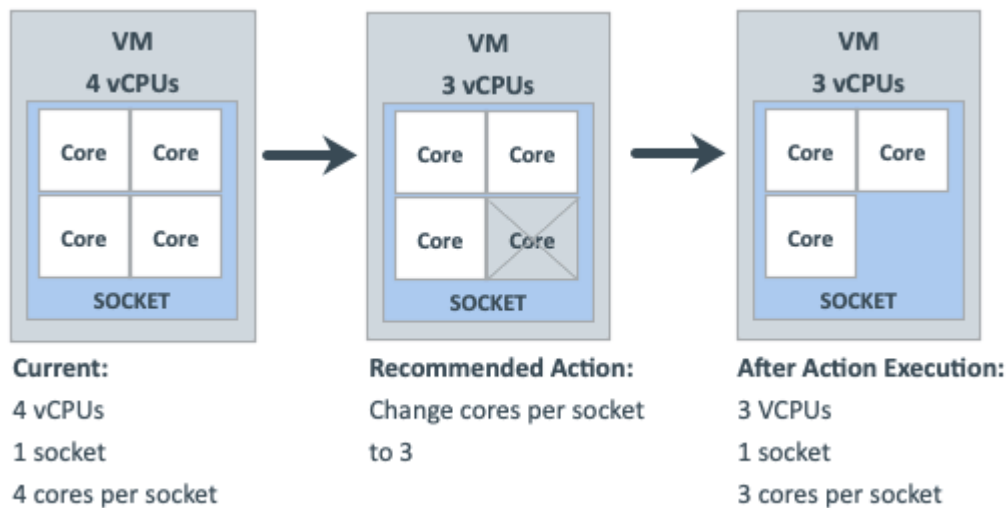
You can also use the 'Match Host Sockets' scaling option (discussed below) for NUMA sensitive VMs.

For example, a VM currently has 1 socket and 4 cores per socket, and applies a policy that changes cores per socket and preserves VM sockets. Turbonomic has determined that the VM requires a change in compute capacity of 1 vCPU.

- To increase compute capacity by 1 vCPU, a resize up action changes cores per socket from 4 to 5.



- To reduce compute capacity by 1 vCPU, a resize down action changes cores per socket from 4 to 3.



Change Cores Per Socket and Match Host Sockets

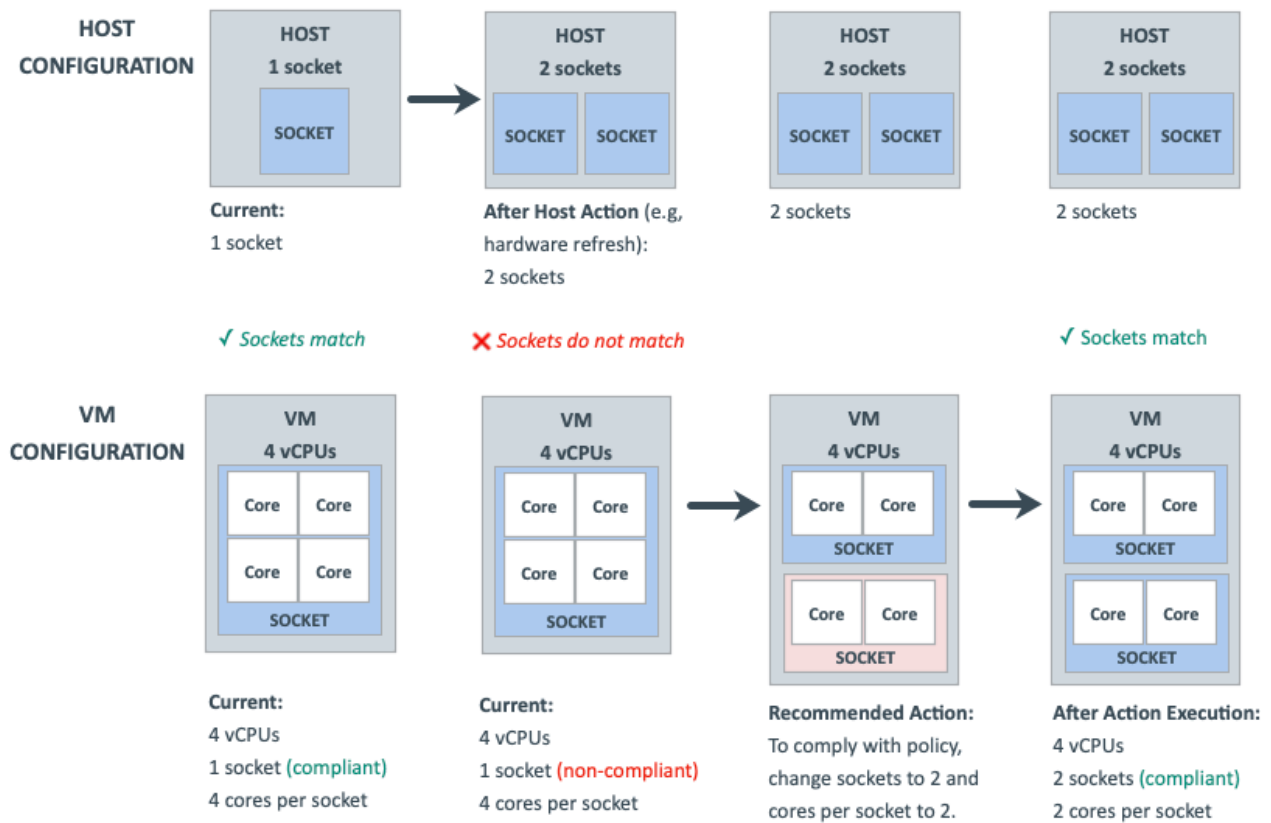
In this scaling option, Turbonomic reconfigures VM sockets to match the number of host sockets, thereby balancing vCPUs evenly across physical sockets. It also changes VM cores per socket to maintain the same compute capacity (vCPU).

This scaling option is ideal under the following scenarios:

- You have large VMs that may realize a performance benefit from reflecting the physical host CPU architecture within the Guest OS so that the application can optimize thread memory access to within a NUMA node.
- You have NUMA sensitive VMs that are migrating between hosts with different CPU architectures. Turbonomic can place the VMs on the best host and then generate an action to reconfigure the VMs to match the host sockets automatically. You can attach a schedule to the policy to automate disruptive reconfigure actions within a maintenance window.

For example, a VM currently has 1 socket and 4 cores per socket, and is on a host with 1 socket. The VM applies a policy that changes cores per socket and matches host sockets. Turbonomic has determined that the VM is already optimally sized, so a resize action is not necessary.

When the host socket value changes from 1 to 2, the VM is suddenly in violation of policy. To bring the VM into compliance while maintaining the same vCPU capacity (since the VM is already optimally sized), Turbonomic must distribute 4 cores between 2 sockets. The end result is 2 sockets and 2 cores per socket.



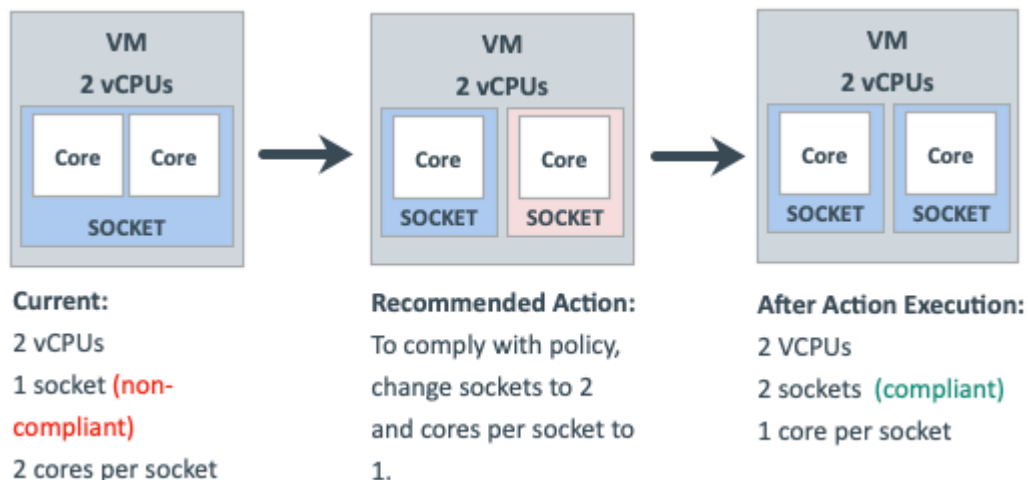
Change Cores Per Socket and Specify Sockets

In this scaling option, Turbonomic reconfigures VM sockets according to the value that you specify, and changes VM cores per socket to maintain the same compute capacity (vCPU).

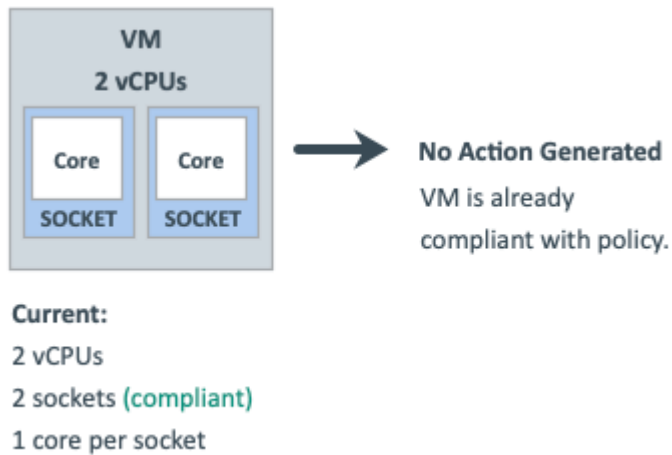
This scaling option is ideal if you have VMs that require a specific socket value for operational policy reasons (such as socket-based licensing or compliance with an application support contract policy).

For example, a VM currently has 1 socket and 2 cores per socket, and applies a policy that changes cores per socket and enforces the user-specified 2 sockets. Turbonomic has determined that the VM is already optimally sized, so a resize action is not necessary.

- Since the VM is in violation of policy, Turbonomic changes sockets from 1 to 2, and cores per socket from 2 to 1.



- When the VM is compliant with policy, no action generates.



Scaling Option: Change MHz Legacy Behavior

In this scaling option, Turbonomic adds or removes compute resources in increments of MHz (1800 MHz by default).

If a VM requires a change to compute resources, Turbonomic generates a resize vCPU action that assumes 1 core per socket, regardless of the VM's actual cores per socket.

If Turbonomic discovers the actual number of cores per socket as part of action execution, it adjusts the action accordingly.

For example, a VM currently has 4 vCPUs with 2 sockets and 2 cores per socket. Turbonomic may generate an action to resize from 4 to 5 vCPUs. However, as part of action execution, the VM socket count changes from 2 to 3, so the end result is 6 vCPUs. Conversely, the same VM may have an action to resize from 4 to 3 vCPUs, but nothing changes as part of action execution.

Hypervisor Support

For **VMware vSphere**, Turbonomic supports all vCPU scaling options, including changing a VM's number of sockets or cores per socket. Increasing the number of sockets is non-disruptive if CPU hot-add is enabled on a VM, while reducing the socket count always requires a restart and is therefore disruptive.

For **Hyper-V** and **Nutanix AHV**, cores per socket and hot-add features have varying degrees of support.

vCPU Scaling Option	vSphere	Hyper-V	Nutanix AHV (Single Core)	Nutanix AHV (Multi Core)
Change virtual CPUs	Supported	Supported	Supported	Not supported by hypervisor
Change sockets – Preserve existing VM cores per socket	Supported	Supported	Supported	Supported
Change sockets – User specified cores per socket	Supported	Not supported by hypervisor	Not supported by hypervisor	Not supported by hypervisor

vCPU Scaling Option	vSphere	Hyper-V	Nutanix AHV (Single Core)	Nutanix AHV (Multi Core)
Change cores per socket – Preserve existing VM sockets	Supported	Not supported by hypervisor Note: Turbonomic assumes one core per socket and only changes sockets.	Not supported by Turbonomic	Not supported by Turbonomic
Change cores per socket – Match host sockets				
Change cores per socket – User specified sockets				

Tie Breakers

When a single VM applies multiple conflicting policies, Turbonomic uses the following tie breakers that follow the principle of least disruptive and most conservative:

- vCPU Scaling Control

"Sockets" wins over "Cores per socket" wins over "Virtual CPU" wins over "MHz legacy behavior".

Note:

Policies created before the introduction of vCPU scaling controls (i.e., any policy before version 8.5.7) will continue to use the "MHz legacy behavior" option but will not be enforced when policy conflicts arise. You can remove these policies or update them to use the newer scaling controls.

- Sockets setting

"Preserve existing VM cores per socket" wins over "User-specified core per socket".

- Cores Per Socket setting

"Preserve existing VM sockets" wins over "User-specified socket" wins over "Match host sockets".

- User-specified value

The lowest value wins.

- Increment Size value

The lowest value wins.

For example, assume a VM belonging to two groups that apply different policies. Policy A changes cores per socket and matches host sockets, while Policy B changes sockets and preserves cores per socket. In this scenario, the VM applies Policy B. Changing sockets wins over changing cores per socket because it is less disruptive.

To see which policies are in effect after the tie-break decision, set the scope to a VM or group of VMs and then click the Policies tab.

Policy Cookbook

Tips:

- Use the following filters when searching for or creating VM groups:
 - Number of vCPUs
 - Number of Sockets
 - Cores per Socket

- Target Type
- Hot-Add Enabled
- For the least disruptive on-demand upsize of vCPU, enable hot-add on the VM and change sockets while preserving cores per socket.
- For the most precise compute resource management, change cores per socket.
- For NUMA considerations, change cores per socket and match host sockets.
- Check Guest OS application and license compatibility when changing vCPU architecture and before automating actions.

How to...

- Manage VM compute capacity by changing the number of vCPUs in increments of 2.

A VM will be reconfigured if required to use 1 core per socket, and resized by changing sockets. Actions are disruptive if the VM does not already have 1 core per socket or if hot-add is not enabled.

1. Create a group of VMs that can have 1 core per socket and scale in sockets.
2. Assign the group a policy with the following settings:

- vCPU Scaling Controls
 - Change: Virtual CPU
 - Increment size: 2
- (Optional) vCPU Resize Min/Max Threshold

- Reconfigure all odd-numbered vCPU VMs to be even-numbered, and then manage compute in even numbers of CPUs.

A VM will be reconfigured if required to use 2 cores per socket, and resized by changing sockets. Actions are disruptive if the VM does not already have 2 cores per socket or if hot-add is not enabled.

1. Create a group of VMs that can have 2 cores per socket and scale in sockets.
2. Assign the group a policy with the following settings:

- vCPU Scaling Controls
 - Change: Sockets
 - User specified cores per socket: 2
- (Optional) vCPU Resize Min/Max Threshold

- Ensure that large VMs always balance their vCPU cores across all physical host sockets (for example, NUMA VMs and Database Server VMs).

A VM will be reconfigured if its socket count does not match the host socket count. The cores per socket count may be adjusted to maintain the overall compute capacity (number of vCPUs). Resize actions are disruptive because cores per socket will change. Reconfigure actions are non-disruptive if VM sockets are increasing, hot-add is enabled, and there are no changes to cores per socket.

1. Create a group of VMs using the filters that you require to identify typically larger VMs.
2. Assign the group a policy with the following settings:

- vCPU Scaling Controls
 - Change: Cores per socket
 - Sockets: Match host sockets
- (Optional) vCPU Resize Min/Max Threshold

- Keep VMs to 2 sockets only and manage compute by changing cores.

VMs in the group will be reconfigured to 2 sockets if required, and resized by changing the cores per socket count while keeping the sockets fixed at 2, thus ensuring compliance with socket-based licensing. Resize actions are disruptive because cores per socket will change. Reconfigure actions are

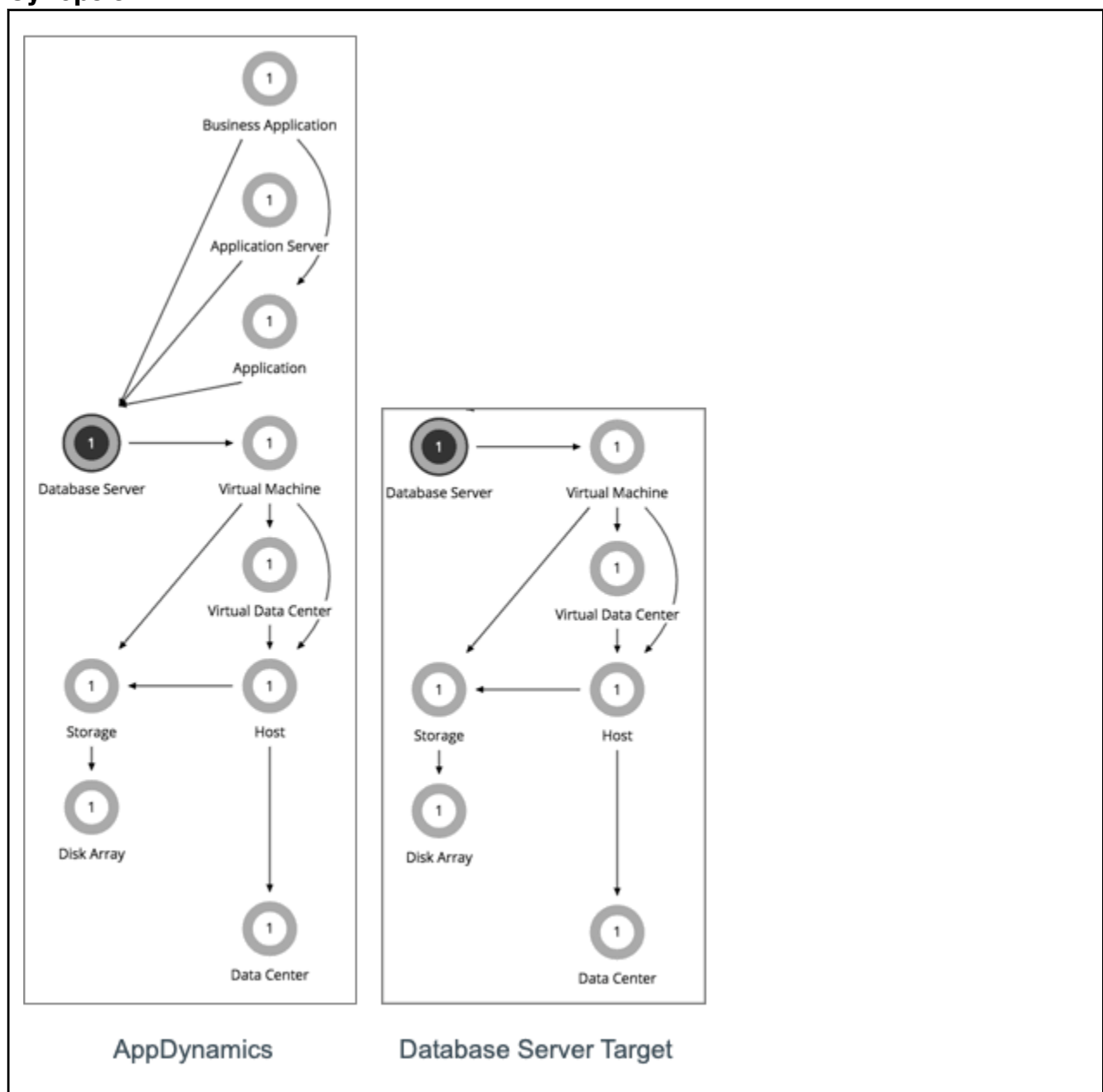
non-disruptive if VM sockets are increasing, hot-add is enabled, and there are no changes to cores per socket.

1. Create a VM group containing the socket-licensed VMs.
2. Assign the group a policy with the following settings:
 - vCPU Scaling Controls
 - Change: Cores per socket
 - User specified sockets: 2
 - (Optional) vCPU Resize Min/Max Threshold

Database Server (On-prem)

For on-prem, a Database Server is a database discovered through one of the associated database application targets or through APM solutions.

Synopsis



Synopsis	
Budget:	On-prem Database Servers have unlimited budget.
Provides:	<ul style="list-style-type: none"> • Response Time, Transactions, DBmem, Cache Hit Rate, and TransactionLog to end users • Connections to Application Components
Consumes:	VM resources, including VCPU, VMem, and VStorage
Discovered through:	<ul style="list-style-type: none"> • AppDynamics targets • Database Server targets • Dynatrace MySQL and MSSQL processes • NewRelic Infrastructure Integration (NRI): MySql, MsSql, MongoDB, OracleDB

Monitored Resources

Turbonomic monitors the following resources for an on-prem Database Server:

- Virtual Memory (VMem)

The utilization of the VMem allocated to the hosting VM

Measured in Kilobytes (KB)

- Transactions

The utilization of the allocated transactions per second for the given entity

Measured in transactions per second.

- DBMem

The memory utilized by the database, as a percentage of the memory capacity that is allocated to the database. Note that this resource is more accurate than the VMem resource on the hosting VM. With this resource, Turbonomic can drive resize and move actions based on the memory consumed by the database, not the memory consumed by the VM.

- Connections

The utilization of the connection capacity. Only applicable to database servers

Measured in Connections

- DB Cache Hit Rate

The percentage of accesses that result in cache hits.

Measured as a percentage of hits vs total attempts (%)

Actions

Resize

Resize the following resources:

- Connections
- DBMem
- Transaction Log

Resize actions based on the Transaction Log resource depend on support for vStorage in the underlying hypervisor technology. Because current versions of Hyper-V do not provide API support for vStorage,

Turbonomic cannot support Transaction Log resize actions for database servers running on the Hyper-V platform.

On-prem Database Server Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

Action	Default Mode
Resize	Manual
Resize DBMem (Up/Down)	Manual

You can use [Action Scripts](#) and third-party orchestrators (such as ServiceNow) for action orchestration.

Transaction SLO

Transaction SLO determines the upper limit for acceptable transactions per second. When the number of transactions reaches the given value, Turbonomic sets the risk index to 100%.

Attribute	Default Setting/Value
Enable Transaction SLO	Off
Transaction SLO	None If you enable SLO, Turbonomic uses the default value of 10. You can change this to a different value.

Response Time SLO

Response time SLO determines the upper limit for acceptable response time (in milliseconds). If response time reaches the given value, Turbonomic sets the risk index to 100%.

Attribute	Default Setting/Value
Enable Response Time SLO	Off Turbonomic estimates SLO based on monitored values.
Response Time SLO [ms]	None If you enable SLO, Turbonomic uses the default value of 2000. You can change this to a different value.

DBMem Utilization

The utilization that you set here specifies the percentage of the existing capacity that Turbonomic will consider to be 100% of capacity.

Attribute	Default Value
DBMem Utilization (%)	100

For example, a value of 80 means that Turbonomic considers 80% utilization to be 100% of capacity. Turbonomic recommends actions that avoid utilization beyond the given value.

DBMem Scaling Increment

This increment specifies how many units to add or subtract when scaling DBMem.

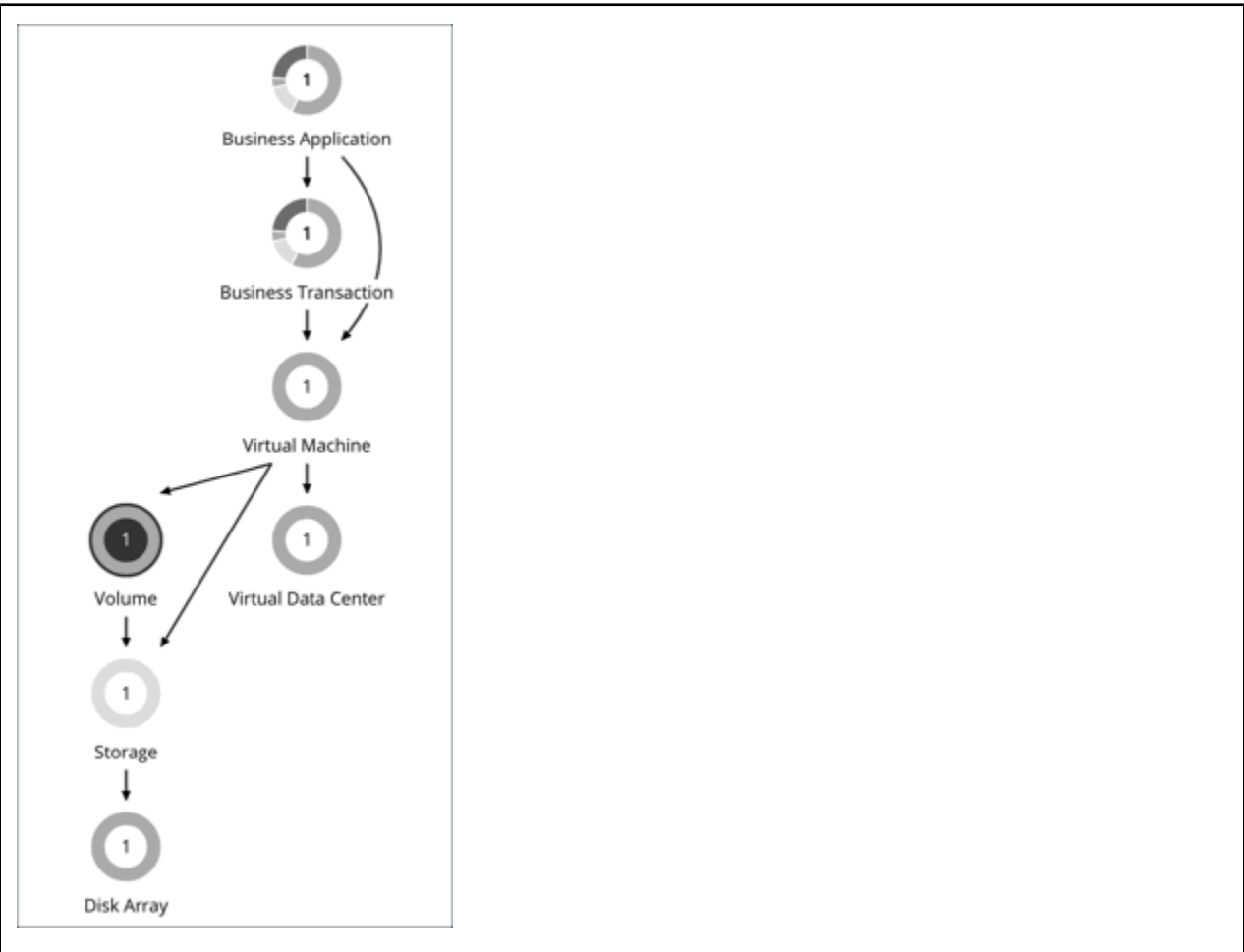
Attribute	Default Value
DBMem Scaling Increment (MB)	128

Do not set the increment value to be lower than what is necessary for the database server to operate. If the increment is too low, then it's possible there would be insufficient DBMem. When reducing allocation, Turbonomic will not leave a database server with less than the increment value. For example, if you use the default 128, then Turbonomic cannot reduce DBMem to less than 128 MB.

Volume (On-prem)

On-prem volumes represent VM disks discovered by hypervisor targets. A VM will have one volume for each configured disk and another volume (representing the configuration) that always moves with Disk 1.

Synopsis



Synopsis	
Budget:	An on-prem volume gains its budget by selling resources to the VMs that it serves.
Provides:	Storage resources for VMs to use. Set the scope to a volume and view the Entity Information chart to see a list of VM-related files (such as VMDKs) contained in the volume. Set the scope to a VM to see a list of volumes attached to the VM.
Consumes:	Datacenter resources
Discovered through:	Hypervisor targets

Actions

Move

Move a VM's volume due to excess utilization of the current datastore, or for more efficient utilization of datastores in the environment. To evaluate and execute actions, set the scope to the VM to which a volume is attached.

Note:

The default global policy includes a setting that directs Turbonomic to use relevant metrics when analyzing and recommending actions for volumes. For details, see [Enable Analysis of On-prem Volumes](#).

On-prem Volume Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Placement Policies

By default, all on-prem volumes associated with a storage will move together rather than independently. You can create placement policies to place individual volumes on groups of storage. To ensure successful placement, be sure to also turn on the setting [Enable Analysis of On-prem Volumes](#) in the default global policy.

For more information, see [Creating Placement Policies](#) and [Enable Analysis of On-prem Volumes](#)

Action Automation and Orchestration

Action	Default Mode
Move	Manual

Cloud Storage Tiers

This policy setting works with plans that simulate migration of on-prem volumes to the cloud. When you create the policy, be sure to set the scope to on-prem volumes and then select the cloud storage tiers that they can migrate to. Turbonomic treats these tiers as constraints when you run a Migrate to Cloud plan that includes the volumes defined in the policy.

Attribute	Default Value
Cloud Storage Tiers	None

Click **Edit** to set your preferences. In the new page that displays, expand a **cloud tier** (a family of instance types, such as *Premium*) to see individual instance types.

Select your preferred instance types or cloud tiers, or clear the ones that you want to avoid. After you save your changes, the main page refreshes to reflect your selections.

Virtual Datacenter (Private Cloud)

A virtual datacenter (vDC) is a collection or pool of resources that groups the resources around specific requirements or business needs. In private cloud environments, Turbonomic discovers the infrastructure that provides resources to the cloud, and the workloads that run on the cloud. To manage these resources, private clouds organize the infrastructure into Provider and Consumer Virtual Datacenters.

Note:

Different targets use different names to refer to Virtual Datacenters. In the Turbonomic supply chain, these entities are all represented by Consumer and Provider VDCs, as follows:

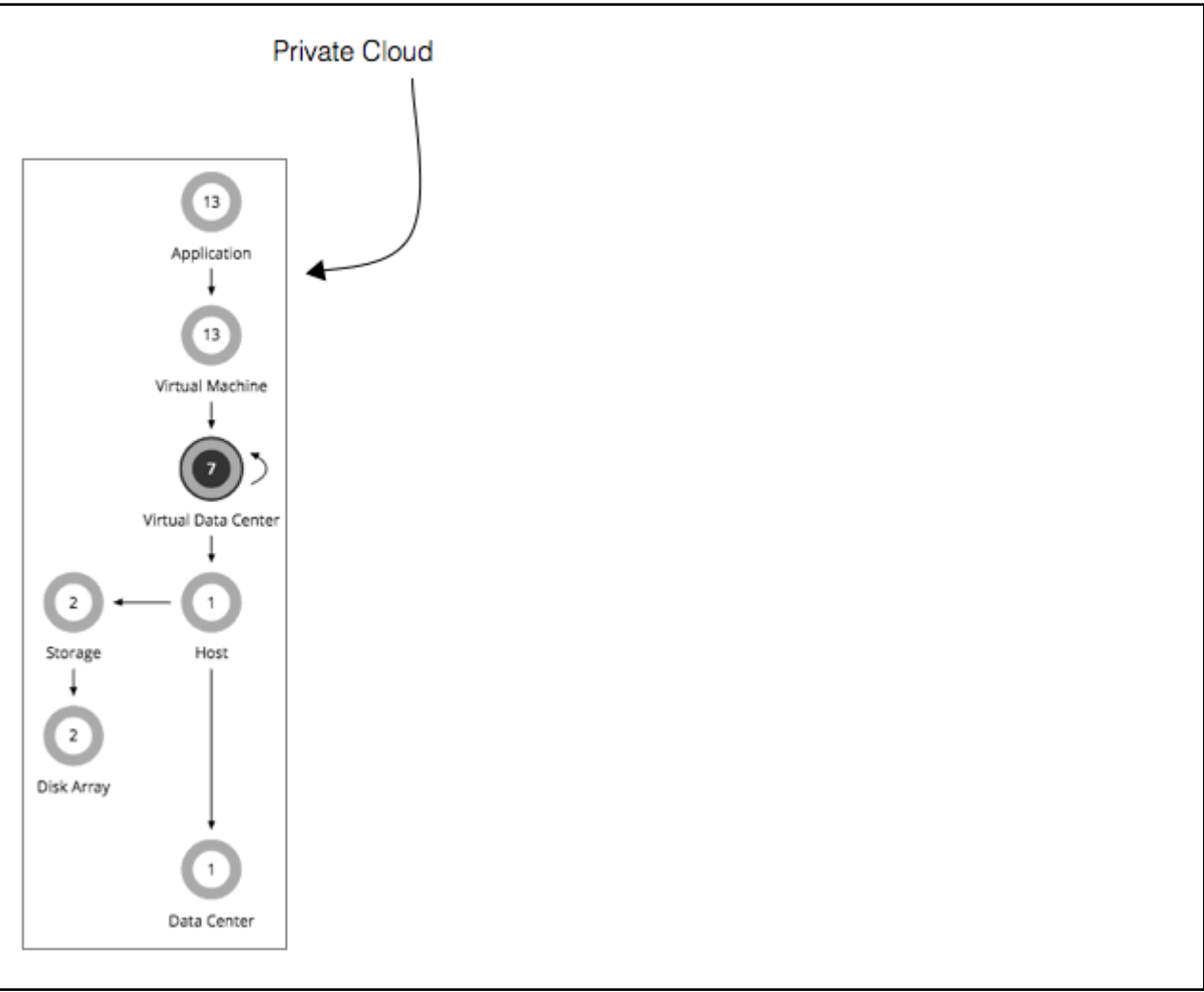
Turbonomic	vCloud Director	vCenter Server	VMM
Consumer VDC	Organization VDC	Resource Pool (Child)	Tenant or TenantQuota

Turbonomic	vCloud Director	vCenter Server	VMM
Provider VDC	Provider VDC	Resource Pool (Root)	Cloud

Provider Virtual Datacenters

A provider virtual datacenter (vDC) is a collection of physical resources (hosts and datastores) within a cloud stack. The cloud administrator has access to these resources, and defines the datacenter members. A Provider vDC is created to manage resources that will be allocated to external customers through one or more Consumer vDCs.

Synopsis



Synopsis

Budget:	A Provider vDC gains its budget by selling resources to the Consumer vDCs that it hosts. If utilization falls off, the datacenter loses budget. Ultimately, if the budget isn't enough to pay for the services it consumes, Turbonomic will recommend decommissioning the Provider vDC.
Provides:	Physical resources such as hosts and datastores to Consumer vDCs.
Consumes:	Hosts and datastores from the physical infrastructure

Synopsis

Discovered through:	Turbonomic discovers vDCs through private cloud stack managers such as vCloud Director.
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Monitored Resources

Turbonomic monitors the following resources for a Provider vDC:

- Memory (Mem)

The utilization of the Datacenter's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the Datacenter's CPU reserved or in use

Measured in Megahertz (MHz)

- Storage

The utilization of the storage attached to the Provider vDC.

Measured in Kilobytes (KB)

Actions

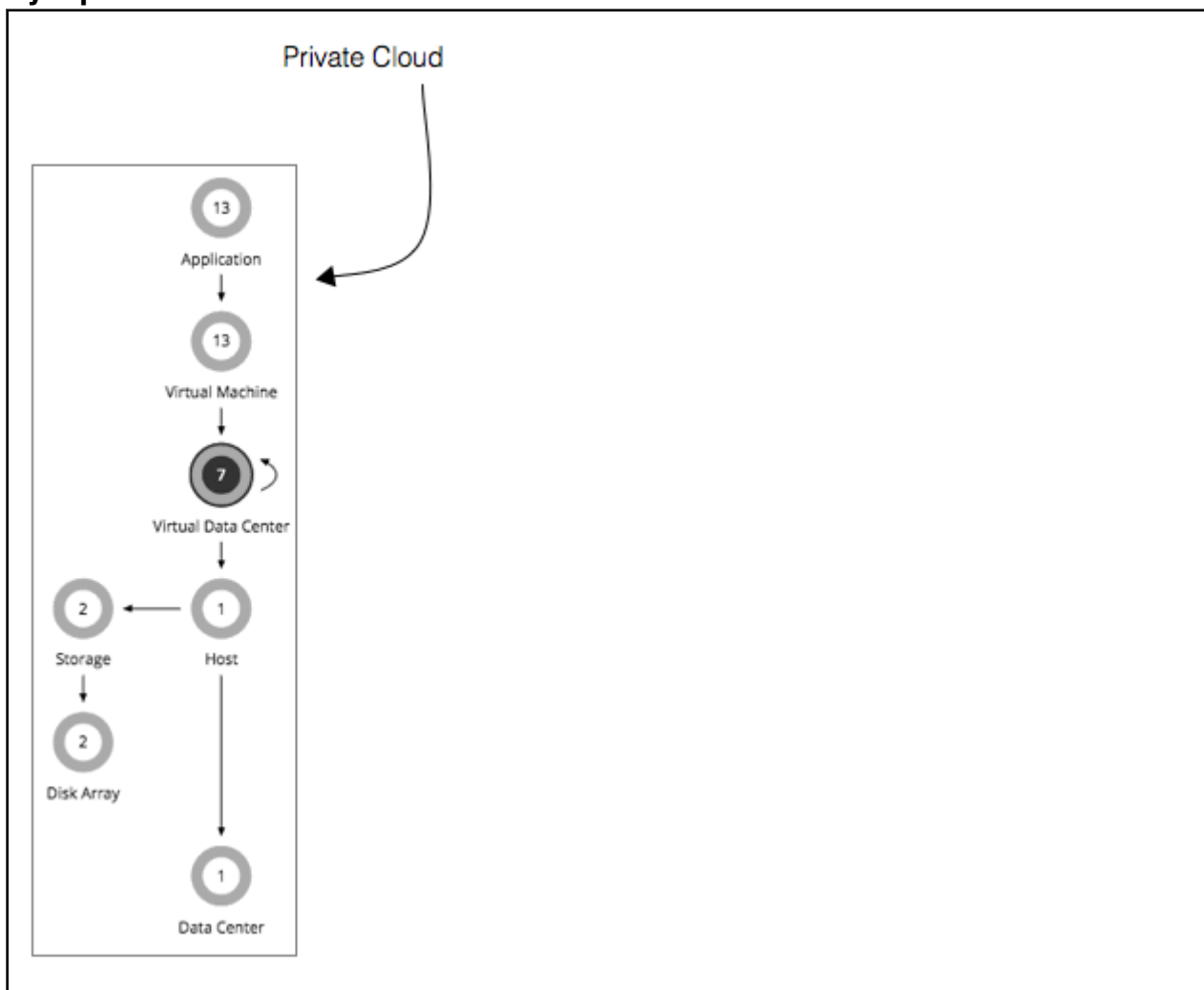
None

Turbonomic does not recommend actions for a Virtual Datacenter. Instead, it recommends actions for the entities that provide resources to the Virtual Datacenter.

Consumer Virtual Datacenters

A Consumer Virtual Datacenter (vDC) is a collection of resources that are available for external customers to manage workload through the private cloud. It is an environment customers can use to store, deploy, and operate virtual systems. Consumer Datacenters use the resources supplied by a Provider Datacenter.

Synopsis



Synopsis

Budget:	<p>A Consumer vDC gains its budget as a function of its activity. The higher the utilization of the vDC, the more Turbonomic assumes the vDC is selling its services to a user.</p> <p>If utilization is high enough on a Consumer vDC, Turbonomic can increase resources for the vDC. If utilization falls off, Turbonomic can reduce resource capacity, or ultimately recommend terminating the vDC.</p> <p>Turbonomic can also resize VMs through the Consumer vDC in response to changes in VM utilization.</p>
Provides:	Resources to host virtual systems.
Consumes:	Provider vDC
Discovered through:	Turbonomic discovers vDCs through cloud stack managers such as vCloud Director.

While users can see some of the physical resources that support the Consumer vDC, consumer-level users cannot modify these physical resources. Users of Consumer vDCs make changes to how the virtual devices are deployed in that environment, but they must ask the Provider vDC administrator to add more

physical resources to be used by the Consumer vDC. Likewise, Turbonomic can change resources on the VMs running in the vDC, but it does not make any changes to physical resources through this vDC.

Monitored Resources

Turbonomic monitors the following resources for a Consumer vDC:

- Memory (Mem)

The utilization of the Datacenter's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the Datacenter's CPU reserved or in use

Measured in Megahertz (MHz)

- Storage

The utilization of the storage attached to the Consumer vDC.

Measured in Kilobytes (KB)

Actions

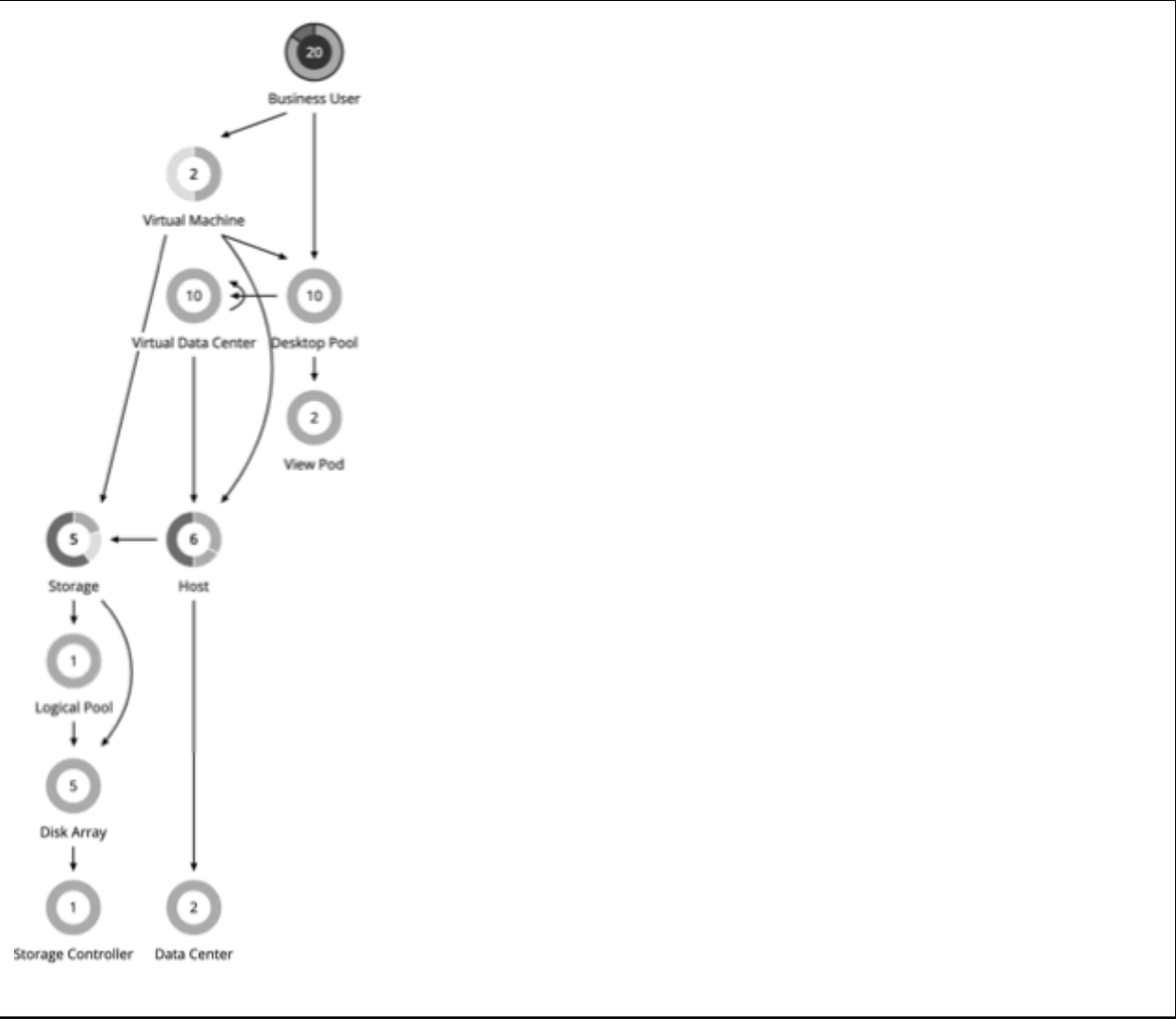
Turbonomic does not recommend actions to perform on a Consumer vDC. Instead, it recommends actions to perform on the entities running in the Provider vDC.

Business User

For Virtual Desktop Infrastructure (VDI) environments, a Business User is a user account that is entitled to launch one or more active VDI sessions. As it discovers desktop pools, Turbonomic creates Business User entities for each user that is entitled to a pool. One business user can be entitled to more than one desktop pool.

To properly work with Business User entities, Turbonomic discovers user information through the LDAP server that manages users for the VDI environment. Note that the account Turbonomic uses to connect to the LDAP server must be trusted for the same domains as are the users in your environment.

Synopsis



The Supply Chain shows relationships of Business Users to Desktop Pools and also to VMs. One Business User can have access to multiple Desktop Pools. When a Business User has an active session, the Supply Chain shows a direct link between the user and the VM that hosts the session. However, Turbonomic does not consider this direct connection when analyzing compute resources. Instead, Business Users utilize Desktop Pool resources, and the Desktop Pools use compute resources from the underlying Virtual Datacenters.

Synopsis	
Budget:	A Business User has unlimited budget.
Provides:	N/A

Synopsis

Consumes:	<p>Resources from the underlying desktop pools:</p> <ul style="list-style-type: none">• Sessions• Pool Memory• Pool Storage• Pool CPU <p>When a Business User has an active session, the Supply Chain shows it in relation to the VM that hosts the session. The Business User consumes the VM's compute resources to support the session requirements for ImageCPU, ImageMem, and ImageStore resources.</p>
Discovered through:	<p>The LDAP server that manages these users. You can specify the LDAP server as part of the target configuration, or Turbonomic can discover it in association with the VDI target.</p>

Monitored Resources

Turbonomic monitors the following resources for a Business User:

- ImageCPU
CPU utilization, as a percentage of CPU capacity for the user's desktop image or images.
- ImageMem
Memory utilization, as a percentage of Memory capacity for the user's desktop image or images.
- ImageStorage
Storage utilization, as a percentage of storage capacity for the user's desktop image or images.

Business User Actions

Move

Move a Business User between desktop pools to address:

- Resource congestion on the image
When utilization is consistently near capacity for image resources, Turbonomic can recommend moving a Business User to a desktop pool that serves larger images.
- Resource congestion on the desktop pool
When utilization is consistently near capacity for the desktop pool, Turbonomic can recommend moving a Business User to a desktop pool that has more available resources.

Note:

To support moves, you must configure placement policies that merge *similarly configured* desktop pools. For details, see [Desktop Pool Placement Policies](#).

Business User Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about Business User actions, see [Business User Actions](#).

Action	Default Mode
Move	Recommend

Image Target Utilization

Turbonomic tracks utilization of desktop image resources for the Business Users in your Virtual Desktop Infrastructure (VDI) environment.

Attribute	Default Value
Image CPU Target Utilization	70 The target utilization as a percentage of CPU capacity.
Image MEM Target Utilization	90 The target utilization as a percentage of memory capacity.
Image Storage Target Utilization	90 The target utilization as a percentage of storage capacity.

Aggressiveness and Observation Period

Turbonomic uses these settings to calculate utilization percentiles. It then recommends actions to improve utilization based on the observed values for a given time period.

• Aggressiveness

Attribute	Default Value
Aggressiveness	95th Percentile

When evaluating utilization of compute and storage resources, Turbonomic considers a given utilization percentile. For example, assume a 95th percentile. The maximum utilization would be the highest value that 95% of the observed samples fall below.

Using a percentile, Turbonomic can recommend more relevant actions, so that analysis can better exploit elasticity in your environment. A percentile evaluates the sustained resource utilization, and ignores bursts that occurred for a small portion of the samples. You can think of this as aggressiveness of resizing, as follows:

- 100th Percentile – The least aggressive, recommended for critical workloads that need maximum guaranteed performance at all times.
- 95th Percentile (Default) – The recommended setting to achieve maximum performance and savings.
- 90th Percentile – The most aggressive, recommended for non-production workloads that can stand higher resource utilization.

• Max Observation Period

Attribute	Default Value
Max Observation Period	Last 7 Days

To refine the calculation of resource utilization, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. (If the database has fewer days' data then it uses all of the stored historical data.)

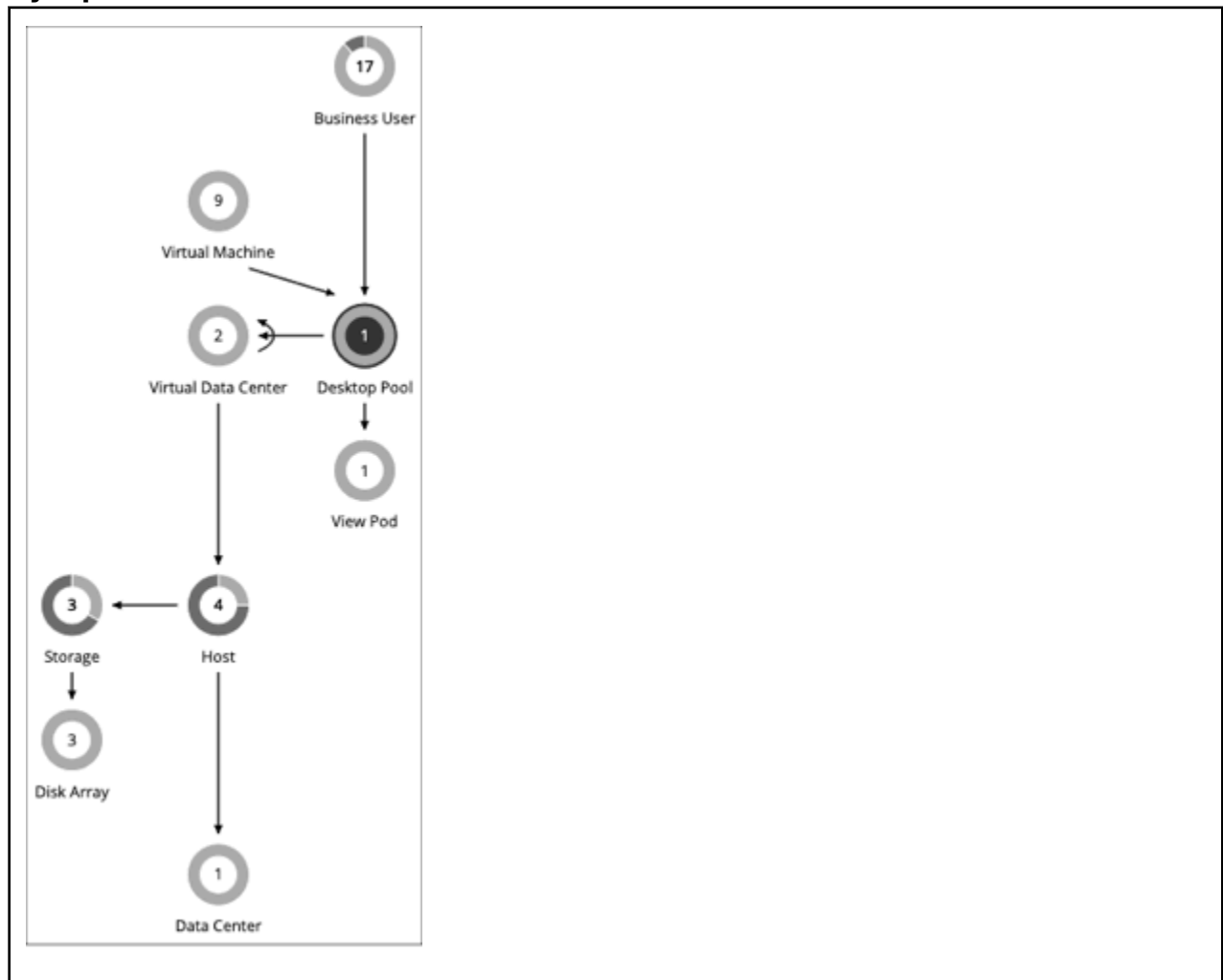
A shorter period means there are fewer data points to account for when Turbonomic calculates utilization percentiles. This results in more dynamic, elastic moves to different Desktop Pools, while a longer period results in more stable or less elastic moves. You can make the following settings:

- Less Elastic – Last 90 Days
- More Elastic – Last 30 Days
- (Default) Most Elastic – Last 7 Days

Desktop Pool

For Virtual Desktop Infrastructure (VDI) environments, a desktop pool is a collection of desktops that users can select from. The desktop pool can provide logical grouping of desktops according to user roles, assignment type (dedicated or floating), and the source of resources (physical host or VM).

Synopsis



The desktop pool gets compute and storage resources from the underlying Virtual Datacenter. For VMware Horizon View, the VDI architecture includes one or more vCenter Server instances. When it discovers the Horizon View target, Turbonomic also discovers the supporting vCenter Server instances, and their corresponding Virtual Datacenters. These are the source of compute and storage resources for the associated desktop pools.

Synopsis	
Budget:	A Desktop Pool gets its budget by selling resources to Business Users.
Provides:	Resources for Business Users to use: <ul style="list-style-type: none"> • PoolMEM • PoolCPU • Sessions
Consumes:	<ul style="list-style-type: none"> • Compute and storage resources from the associated Virtual Datacenters • Sessions from the underlying View Pod
Discovered through:	<p>The VDI management target.</p> <p>For VMware Horizon View, the target is the View Connection Server.</p>

Monitored Resources

Turbonomic monitors the following resources for a Desktop Pool:

- Pool CPU

The CPU available to the pool that is in use by active sessions.

- Pool Memory

The memory available to the pool that is in use by active sessions.

- Pool Storage

The storage capacity available to the pool that is in use by active sessions.

- Active Sessions

How many active sessions are on the pool as a percentage of the pool's capacity as defined in the Turbonomic policy.

- Total Sessions

How many active and disconnected (non-terminated) sessions are on the pool, as a percentage of the pool's capacity.

Actions

None

Turbonomic does not recommend actions for a desktop pool. It recommends actions for the Business Users running active sessions in the pool.

Desktop Pool Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

None

Turbonomic does not recommend actions for a desktop pool. It recommends actions for the Business Users running active sessions in the pool.

Observation Settings

Turbonomic uses these settings to decide whether to move Business Users from one desktop pool to another.

• Daily Observation Windows

Attribute	Default Value
Daily observation windows	3 windows per day

When evaluating utilization of pool resources, Turbonomic divides each day into different observation windows, calculates an average for each, and uses the highest value. In this way, Turbonomic can account for high-use periods in the day to base calculations off of the most representative usage of the desktop images.

Assume three observation windows:

Window	Time range	Average utilization
W1	00:00 – 08:00	10%
W2	08:00 – 16:00	80%
W3	16:00 – 24:00	40%

Average utilization for this day *without* the benefit of observation windows would be 44%. By using observation windows we can see that the representative utilization of pool resources is closer to 80%. That is because Turbonomic discovers an average utilization of 80% during the high-usage time of day.

When calculating whether to move business users from one desktop pool to another, Turbonomic averages the observation windows over the time you set for the Max Observation Period. For this reason, you should try to set up observation windows that capture the best representation of work habits amongst your business users.

• Max Observation Period

Attribute	Default Value
Max Observation Period	Last 7 Days

To refine the calculation of resource utilization, you can set the sample time to consider. Turbonomic uses historical data from up to the number of days that you specify as a sample period. (If the Turbonomic database has fewer days' data, then it uses all of its stored historical data.)

A shorter period means there are fewer data points to account for when Turbonomic calculates utilization. This results in more dynamic, elastic resizing, while a longer period results in more stable or less elastic resizing. You can make the following settings:

- Less Elastic – Last 30 Days
- Recommended – Last 7 Days
- More Elastic – Last 3 Days

Pool Utilization

These settings affect the actions Turbonomic recommends as it manages business users and active accounts on the desktop pool. Turbonomic recommends actions that avoid using these resources beyond the given settings.

Attribute	Default Value
Pool CPU Utilization	95
Pool Mem Utilization	95
Pool Storage Utilization	95

The values you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity. For example, setting 70 for Desktop Pool Pool CPU Utilization means that Turbonomic considers 70% utilization of that CPU to be 100% of capacity and 35% utilization to be 50% of capacity.

Placement Policies

Under some circumstances, you can have Business Users who need larger desktop images. This appears as users with high utilization of the image resources. In this case, Turbonomic can recommend moving the Business Users to a different desktop pool that serves up larger images.

To support moving Business Users, you must create a placement policy that merges desktop pools. Be sure to merge only desktop pools that are *similarly configured* – they should run the same operating system and applications, and differ only in allocated memory and/or CPU.

To merge desktop pools:

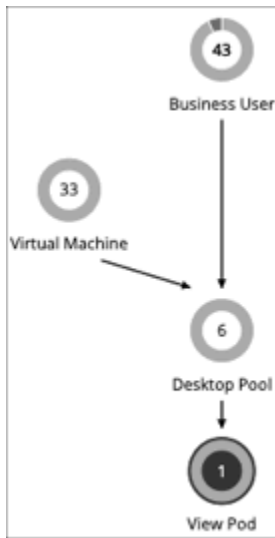
1. Create a new placement policy.
2. Choose **Merge** as the policy type.
3. For the consumer type to merge, choose **Desktop Pool**.
4. Choose the pools that you want to merge.
5. Save the policy.

For more information, see [Creating Placement Policies](#).

View Pod

For Virtual Desktop Infrastructure (VDI) environments, a View Pod groups together a given set of Desktop Pools.

Synopsis



Synopsis

Budget:	A View Pod has unlimited budget.
Provides:	Active Sessions.
Consumes:	N/A
Discovered through:	The VDI management target. For VMware Horizon View, the target is the View Connection Server.

Monitored Resources

Turbonomic monitors the following resources for a Desktop Pool:

- Active Sessions

How many active sessions are on the pool as a percentage of the pool's capacity as defined in the Turbonomic policy.

- Total Sessions

How many active and disconnected (non-terminated) sessions are on the pool, as a percentage of the pool's capacity.

Actions

None

Turbonomic does not recommend actions for a view pod. Instead, it recommends actions for the Business Users that are running active sessions.

Active Session Capacity for View Pods

Each View Pod entity has a set capacity of active sessions. By default, Turbonomic assumes a capacity of 8,000. So that Turbonomic can generate reliable actions for Business User entities, you must set this capacity to match the active session capacity that your Horizon administrator has deployed for the given view pod.

Once you know the correct active session capacity for your view pod, create an automation policy that sets the capacity. For complete information about creating automation policies, see [Creating Scoped Automation Policies](#). For information about view pod policies, see [View Pod Policies](#).

1. Create a new scoped automation policy.

Navigate to the Settings Page and choose **Policies**. Then click **NEW AUTOMATION POLICY**, and select View Pod as the policy type. Be sure to name the new policy.

2. Set the policy scope to your view pod.

To define its scope, you assign a group to the policy. You will have to create the group for this view pod:

- Expand the **SCOPE** section and then click **ADD VIEW POD GROUPS**.
- Choose the group that contains only the view pod you want to configure.

If it has already been created, choose the group from the list. If the group does not appear, click **NEW GROUP** to create a static group that includes only the view pod you want to configure. For more information about creating groups, see [Creating Groups](#).

Choose the group you want and click **SELECT**. This returns you to the Configure View Pod Policy fly-out.

3. Set the view pod capacity.

Expand the **UTILIZATION CONSTRAINTS** section and click **ADD UTILIZATION CONSTRAINT**. From the drop-down list, choose Active Sessions Capacity. In the capacity field, enter the capacity that you have calculated for your desktop pools.

4. Save your work

When you're done, be sure to click **SAVE AND APPLY**.

View Pod Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

None

Turbonomic does not recommend actions for a view pod. Instead, it recommends actions for the Business Users that are running active sessions.

Active Sessions Capacity

This setting controls the number of active sessions a given view pod can support.

Attribute	Default Value
Active Sessions Capacity	8000

For each view pod, you should set this value to match the active session capacity that has been deployed in your VDI environment for the given view pod. For more information, see [Active Session Capacity for View Pods](#).

Host

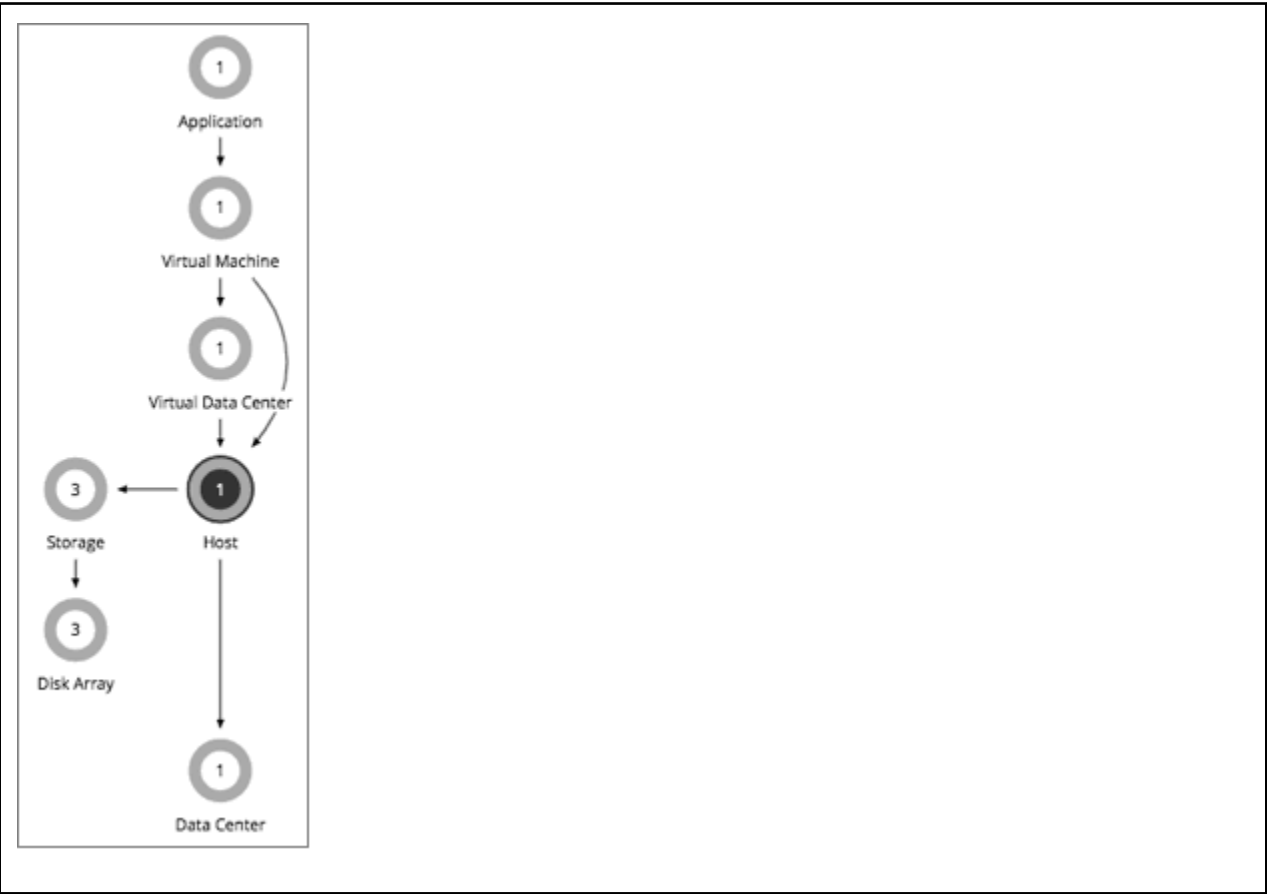
For on-prem environments, a host is a server that runs processes, including hypervisor processes to host virtual workloads. Note that a host is not necessarily a physical piece of hardware. A VM can be set up as a server that runs a hypervisor, and in turn it can host other VMs within its processing space. However, it's most usual to use physical hardware as your hosts.

Note:

To support vSAN storage in your environment, you can deploy HCI Hosts. Turbonomic discovers the vSAN as a storage entity that consumes resources from the underlying hosts. For more information, see [vSAN Storage](#).

On the public cloud a host is an availability zone. This is where your cloud workloads run. For details, see [Zone](#).

Synopsis



Synopsis

Budget:	A host gains its budget by selling resources to the workloads that run on it. The more workloads running on a host, the more budget the host has to purchase storage and datacenter resources. If utilization of a host is high enough, Turbonomic can recommend that you provision a new one. If utilization falls off, the host loses budget. Ultimately, if the budget isn't enough to pay for the services it consumes, Turbonomic will recommend to suspend or power off the host.
---------	---

Synopsis

Provides:	Host resources for VMs to use: <ul style="list-style-type: none">• Mem (Kbytes)• CPU (MHz)• IO (throughput on the I/O bus)• Net (network throughput)• Swap (swap rate capacity measured in bytes/sec)• Ballooning (sharing of memory among hosted VMs)• CPU Ready Queue (wait time on the queue in ms)
Consumes:	Datacenter resources (physical space, cooling, etc.) and storage.
Discovered through:	Turbonomic discovers hosts through hypervisor targets. For some hypervisor vendors, the host is the target, and for others the hosts are managed by the specified target.

Monitored Resources

Turbonomic monitors the following resources on a host:

- Memory (Mem)

The utilization of the PM's memory reserved or in use

Measured in Kilobytes (KB)

- CPU

The utilization of the PM's CPU reserved or in use

Measured in Megahertz (MHz)

- IO

The utilization of the PM's IO adapters

Measured in Kilobytes per second (KB/s)

- Net

The utilization of data through the PM's network adapters

Measured in Kilobytes per second (KB/s)

- Swap

The utilization of the PM's swap space

Measured in Kilobytes (KB)

- Balloon

The utilization of shared memory among VMs running on the host. ESX-only

Measured in Kilobytes (KB)

- CPU Ready

The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only

Measured in Megahertz (MHz)

Actions

- **Start**

Start a suspended host when there is increased demand for physical resources.

- **Provision**

Provision a new host in the environment when there is increased demand for physical resources. Turbonomic can then move workloads to that host.

- **Suspend**

When physical resources are underutilized on a host, move existing workloads to other hosts and then suspend the host.

- **Reconfigure**

Turbonomic generates this action in response to changing demand for software licenses. For details, see [License Policy](#).

Note:

Turbonomic discovers VMware HA configurations in clusters, and considers the reserved resources in its calculations. For tolerated host failures, or a reserved percentage of cluster resources, Turbonomic automatically sets utilization constraints for that cluster. If you configure a failover host, Turbonomic reserves that host for HA and will not move VMs to it.

DRS Automation Settings

Turbonomic automatically discovers DRS automation settings for vSphere hosts managed through vCenter. When you set the scope to a vSphere host and then view the Entity Information chart, the following information displays:

- Vendor Automation Mode

The chart shows the automation mode discovered from vCenter – Not Automated, Partially Automated, or Fully Automated.

- Vendor Migration Level

Turbonomic assigns a vendor migration level based on the migration level discovered from vCenter. The chart only shows the assigned migration level (i.e., the Turbonomic Vendor Migration Level).













Turbonomic Vendor Migration Level	vCenter Migration Level
1 (Conservative)	5
2 (Less Conservative)	4
3 (Moderate)	3
4 (Less Aggressive)	2
5 (Aggressive)	1

Host Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For details about host actions, see [Host Actions](#).

Action	Default Mode	vCenter	Hyper-V	UCS (blades only)
Start	Recommend			
Suspend	Recommend			
Provision	Recommend			
Reconfigure	Recommend			

You can use Action Scripts for action orchestration.

For ServiceNow:

- Host provision actions will not generate a CR.
- For host suspend actions to succeed, it must be enabled in the given hypervisor, and there must be no VMs currently running on that host.

Utilization Constraints

Utilization constraints affect the actions Turbonomic recommends as it manages your environment. Turbonomic recommends actions that avoid using these resources beyond the given settings. The values you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity.

Attribute	Default Value
Memory Overprovisioned Percentage	1000
Net Throughput	50
Ready Queue Utilization	50
Memory Utilization	100
IO Throughput	50
CPU Overprovisioned Percentage	1000
CPU Utilization	100
Swapping Utilization	20

For example:

- Setting 50 for Net Throughput means that Turbonomic considers 50% utilization of that throughput to be 100% of capacity and 25% utilization to be 50% of capacity
- Setting 1000 for Memory Overprovisioned Percentage means that overprovisioning memory by 5 times the physical capacity shows up as 50% utilization of the Mem Overprovisioned capacity in Turbonomic

- Setting 100 for Memory Utilization means that Turbonomic capacity reflects the physical capacity for this resource

Desired State

The desired state for your environment is an n-dimensional sphere that encompasses the fittest conditions your environment can achieve.

Attribute	Default Value
Diameter	10
Center	70

The multiple dimensions of this sphere are defined by the resource metrics in your environment. Metric dimensions include VMem, storage, CPU, etc. While the metrics on the devices in your environment can be any value, the desired state, this n-dimensional sphere, is the subset of metric values that assures the best performance while achieving the most efficient utilization of resources that is possible.

The Desired State settings define the center of the sphere as well as its diameter. This is a way for you to customize what Turbonomic considers to be the desired state.

Setting the center of the sphere chooses the priority for Turbonomic analysis. If you set the balance in favor of efficiency, Turbonomic tends to place more VMs on fewer physical hosts, and to give them storage capacity from fewer data stores. As a result, high utilization can have more impact on QoS. With a balance in favor of performance, Turbonomic tends to spread virtual loads across more physical devices. This can result in the provisioning of excess resources.

The diameter setting determines the range of deviation from the center that can encompass the desired state. If you specify a large diameter, Turbonomic will have more variation in the way it distributes workload across hosting devices.

As you move each slider, a tooltip displays the numerical value of the setting. **Center** indicates the percentage of resource utilization you want, within the range you specify as **Diameter**. For example, if you want utilization of 75%, plus or minus 10%, then you would set **Center** = 75 and **Diameter** = 20. Turbonomic recommends actions that tend toward this desired state much as possible, given the dependencies within the current environment.

Note:

The setting for Target Utilization can have an effect on plans that you run. If you disable provisioning and suspension for hosts and datastores, then you should always set Center and Diameter to their default values.

Placement Policies

You can create placement policies that merge multiple clusters into a single logical group for the purpose of workload placement.

For example, you can merge three host clusters in a single provider group. This enables Turbonomic to move workload from a host in one of the clusters to a host in any of the merged clusters to increase efficiency in your environment.

For more information, see [Creating Placement Policies](#).

Note:

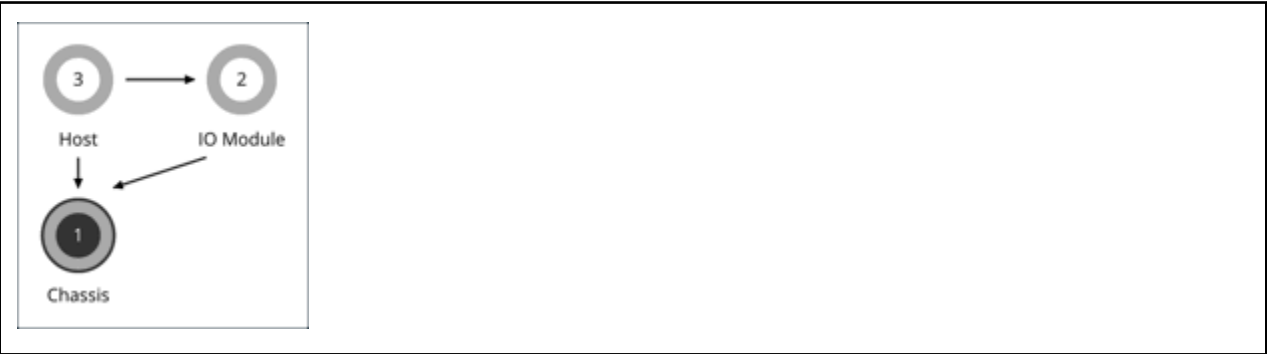
For vCenter, IBM automatically imports any vSphere Host DRS rules when DRS is enabled, and displays them on the **Settings > Policies** page under **Imported Placement Policies**.

For more information, see [Importing Workload Placement Policies](#).

Chassis

A chassis houses the servers that are part of a computing fabric. It provides compute, memory, storage, and bandwidth resources.

Synopsis



Synopsis	
Budget:	A Chassis has unlimited budget.
Provides:	Chassis resources (physical space, cooling, etc.).
Consumes:	N/A
Discovered through:	Turbonomic discovers Chassis through fabric manager targets.

Note:

When Turbonomic discovers that blade servers housed in a particular chassis have been designated as vCenter hosts, the supply chain stitches the blade servers and chassis to the corresponding vCenter datacenter to establish their relationship. When you set the scope to that datacenter and view the Health chart, you will see the blade servers in the list of hosts. In addition, when the datacenter is included in a merge policy (a policy that merges datacenters for the purpose of VM placement), the VMs in the blade servers apply the policy, allowing them to move between datacenters as necessary.

Monitored Resources

Turbonomic monitors the following resources for the servers in a chassis:

- Power
 - Electricity being consumed by the Chassis
 - Measured in Watts (W)
- Cooling
 - The percentage of the acceptable temperature range that is utilized by this chassis. As the chassis temperature nears the high or low running temperature limits, this percentage increases.

Actions

None

Turbonomic does not recommend actions for a chassis.

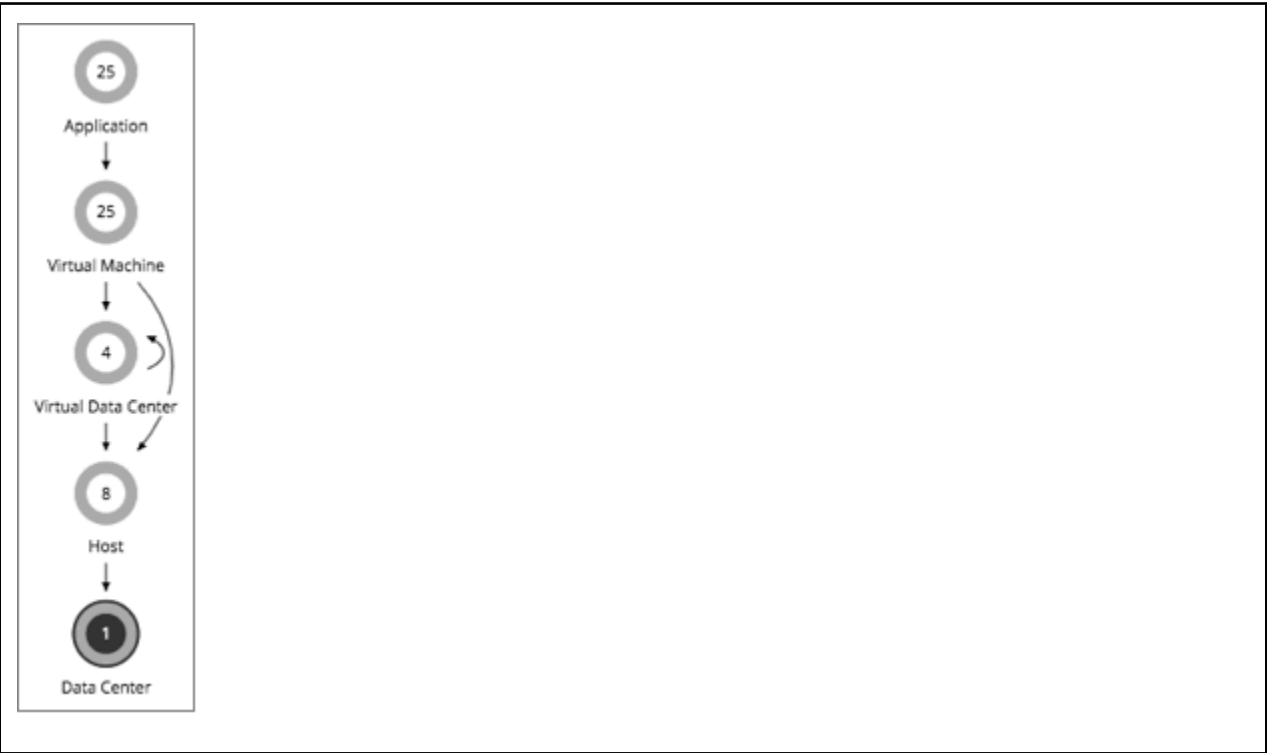
Datacenter

A datacenter is the sum of VMs, PMs, datastores, and network devices that are managed by a given hypervisor target. A datacenter provides compute, memory, storage, and bandwidth resources.

Note:

For public cloud environments, a datacenter is the cloud region. The hosts that get resources from the datacenter are availability zones within that region. For details, see [Region](#) and [Zone](#).

Synopsis



Synopsis	
Budget:	A Datacenter has unlimited budget.
Provides:	Compute, memory, storage, and bandwidth resources
Consumes:	N/A
Discovered through:	Turbonomic discovers Datacenters through hypervisor targets.

Note:

When Turbonomic discovers that blade servers housed in a particular chassis have been designated as vCenter hosts, the supply chain stitches the blade servers and chassis to the corresponding vCenter datacenter to establish their relationship. When you set the scope to that datacenter and view the Health chart, you will see the blade servers in the list of hosts. In addition, when the datacenter is included in a merge policy (a policy that merges datacenters for the purpose of VM placement), the VMs in the blade servers apply the policy, allowing them to move between datacenters as necessary.

Monitored Resources

Turbonomic does not monitor resources directly from the datacenter, but it does monitor the following resources, aggregated for the hosts in a datacenter:

- **Memory (Mem)**
The utilization of the PM's memory reserved or in use
Measured in Kilobytes (KB)
- **CPU**
The utilization of the PM's CPU reserved or in use
Measured in Megahertz (MHz)
- **IO**
The utilization of the PM's IO adapters
Measured in Kilobytes per second (KB/s)
- **Net**
The utilization of data through the PM's network adapters
Measured in Kilobytes per second (KB/s)
- **Swap**
The utilization of the PM's swap space
Measured in Kilobytes (KB)
- **Balloon**
The utilization of shared of memory among VMs running on the host. ESX-only
Measured in Kilobytes (KB)
- **CPU Ready**
The utilization of the PM's allocated ready queue capacity (measured in Kbytes) that is in use, for 1, 2, and 4 CPU ready queues. ESX-only
Measured in Kilobytes (KB)

Actions

None

Turbonomic does not recommend actions for a datacenter. Instead, it recommends actions for the entities running in the datacenter.

Placement Policies

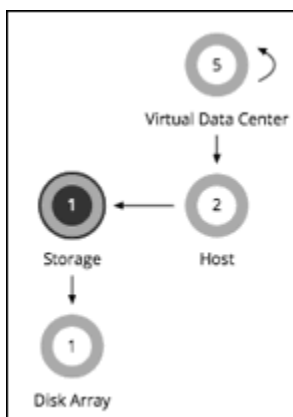
For vCenter environments, you can create placement policies that merge datacenters to support cross-vCenter moves. In this case, where a datacenter corresponds to a given vCenter target, the merged clusters can be in different datacenters. In this case you must create two merge policies; one to merge the affected datacenters, and another to merge the specific clusters.

For more information, see [Creating Placement Policies](#).

Storage

Turbonomic represents storage as Datastores. A Datastore is a logical grouping of one or more physical storage devices that serve workload storage requirements.

Synopsis



Synopsis

Budget:	A Datastore gains its budget by selling resources to the VMs it serves. If utilization of a Datastore is high enough, Turbonomic can recommend that you provision a new one.
Provides:	Host resources for VMs to use: <ul style="list-style-type: none">• Storage amount• IOPS (storage access operations per second)• Latency (capacity for disk latency in ms)
Consumes:	Disk arrays (or aggregates)
Discovered through:	Turbonomic discovers on-prem Datastores through hypervisor targets and storage controllers.

Monitored Resources

Turbonomic monitors the following resources for a datastore:

- Storage Amount

The utilization of the datastore's capacity

Measured in Megabytes (MB)

- Storage Provisioned

The utilization of the datastore's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the datastore

Measured in Operations per second

Note:

When it generates actions, Turbonomic does not consider IOPS throttling that it discovers on storage entities. Analysis uses the IOPS it discovers on Logical Pool or Disk Array entities.

- Latency

The utilization of latency on the datastore

Measured in Milliseconds (ms)

Storage Actions

- **Move**

For high utilization of physical storage, move datastore to a different disk array (aggregate).

- **Provision**

For high utilization of storage resources, provision a new datastore.

- **Resize**

Increase or decrease the datastore capacity.

- **Start**

For high utilization of storage resources, start a suspended datastore.

- **Suspend**

For low utilization of storage resources, move served VMs to other datastores and suspend this one.

- **Delete**

Delete a datastore or volume that has been suspended for a period of time.

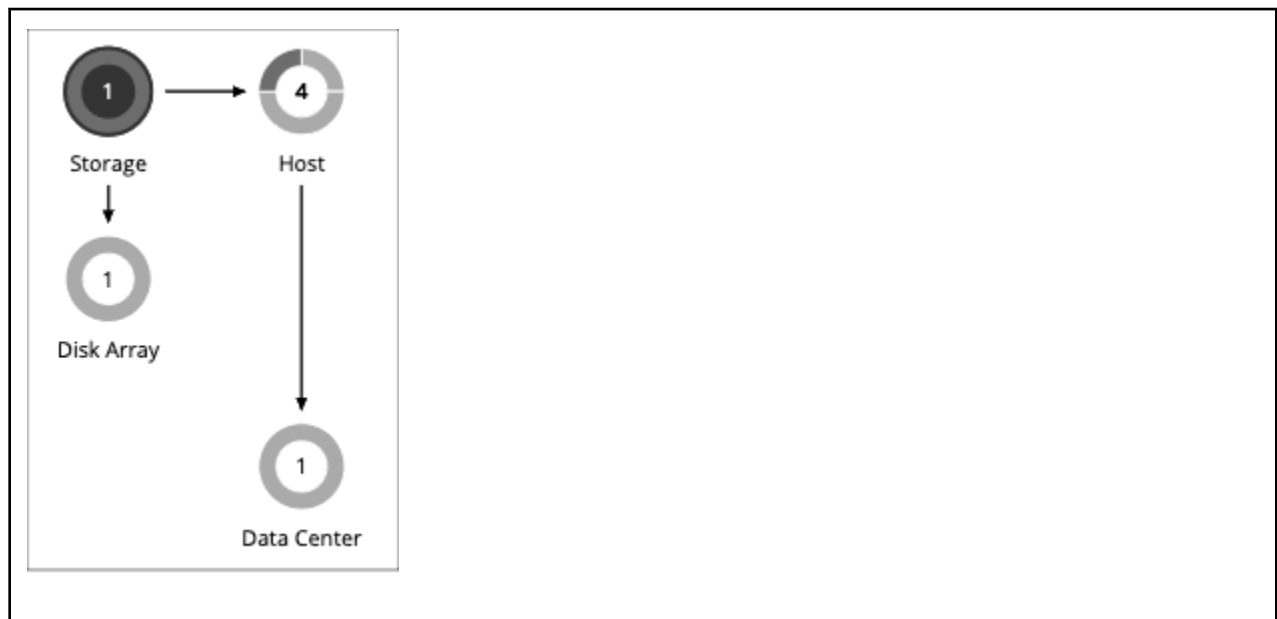
Storage resize actions use Turbonomic tuned scaling settings. This gives you increased control over the action mode Turbonomic will use for the affected actions. For an overview of tuned scaling, see [Tuned Scaling for On-prem VMs](#).

You can create placement policies to enforce constraints for storage move actions. For example, you can have a policy that allows storage to only move to certain disk arrays, or a policy that prevents storage from moving to certain disk arrays.

For more information, see [Creating Placement Policies](#).

vSAN Storage

Overview



For environments that use hyperconverged infrastructure to provide storage on a vSAN, Turbonomic can discover the storage provided by a host cluster as a single Storage entity. This Storage entity represents the full storage capacity that is provided by that host cluster.

Turbonomic supports VMware vSAN, but does not support stretched VSAN clusters. Adding stretched clusters can cause the generation of incorrect storage recommendations and actions.

Turbonomic supports VMware vSAN.

vSAN Storage Capacity

When you consider vSAN capacity, you need to compare *Raw Capacity* with *Usable Capacity*.

- Raw Capacity
- Turbonomic discovers Raw Capacity configured in vCenter and uses it to calculate Usable Capacity. Raw Capacity displays in the Entity Information chart.
- Usable Capacity

Turbonomic calculates Usable Capacity and then uses the calculated value to drive scaling actions. Turbonomic can recommend scaling the Storage Amount, Storage Provisioned, or Storage Access capacity. Usable Capacity displays in the Capacity and Usage chart.

Usable Capacity Calculation

To calculate Usable Capacity, Turbonomic considers a variety of attributes, including:

- Raw Capacity and Largest Host Capacity

Turbonomic compares the Raw Capacity for all the hosts in the cluster and then uses the largest value as Largest Host Capacity.

- RAID Factor

Turbonomic calculates RAID Factor based on the *Failures to Tolerate* (FTT) value and *Redundancy Method* that it discovers. FTT specifies how many failures a given cluster can tolerate, while Redundancy Method specifies the RAID level for the cluster.

FTT	Redundancy Method	RAID Factor
0	RAID1	1
1	RAID1	1/2
2	RAID1	1/3
1	RAID5/6	3/4
2	RAID5/6	2/3

Note:

If discovery fails for some reason, Turbonomic uses a RAID Factor of 1.

- Host Capacity Reservation, Slack Space Percentage, and Compression Ratio

You can control the values for these attributes in storage policies. For details about these attributes and their effect on usable capacity calculations, see [Hyper-converged Infrastructure Settings](#).

The calculation for Usable Capacity can be expressed as:

$$\text{Usable Capacity} = (\text{Raw Capacity} - \text{Largest Host Capacity} * \text{Host Capacity Reservation}) * \text{Slack Space Percentage} * \text{RAID Factor} * \text{Compression Ratio}$$

If the result of the calculation is zero or a negative value, Turbonomic sets the Usable Capacity to 1 MB.

Capacity and Usage Chart for vSAN Storage

The **Capacity and Usage** chart for vSAN storage shows two Storage Amounts - *Consumed* (bought) and *Provided* (sold). This is because vSAN storage can buy and sell commodities to hosts.

For the *Provided* Storage Amount, the *Capacity* value corresponds to *Usable Capacity*, while the *Used* value indicates utilization.

Entity Information Chart for vSAN Storage

The **Entity Information** chart includes the following information:

- HCI Technology Type

The technology that supports this storage cluster. For this release, Turbonomic supports VMware vSAN technology.

- Capacity

Turbonomic displays rounded values for the following, which might be slightly different from the values it discovers from vCenter:

- Raw Capacity

The sum of the Raw Capacity that each storage capacity device provides.

- Raw Free Space

How much of the Raw Capacity is not currently in use.

- Raw Uncommitted Space

In terms of Raw Capacity, how much space is available according to your thin/thick provisioning.

- Redundancy Method and Failures to Tolerate

Redundancy Method specifies the RAID level employed for the cluster. RAID level impacts how much Usable Capacity you can see for a given Raw Capacity. You can use a RAID calculator to determine how the RAID level impacts your Usable Capacity.

Failures to Tolerate specifies how many capacity device failures a given cluster can tolerate. In practical terms, this means how many hosts can come down at the same time, without affecting storage. This value should match the RAID level.

Actions to Add vSAN Capacity

To scale up storage amount, you add additional hosts that are configured to include their storage in the vSAN array.

When you scope the session to the vSAN storage, you can see actions to scale:

- Storage Amount
- Storage Provisioned
- Storage Access

The action to scale up the storage indicates the amount of storage you need to add. It appears as a recommended action. In fact, to add storage you must add a new host.

When you scope the session to hosts that provide the capacity devices to the storage, you can see the following actions that are related to scaling up the storage capacity:

- Scale up StorageAmount for Storage [MyVsanStorageCluster]
- Provision Host [VSAN_HostName]

The action to provision a host includes details about the storage cluster. Because you need to manually add hosts to your on-prem environment, this appears as a recommended action.

Planning With vSAN Storage

For *Hardware Replace* and *Custom* plans, you can use HCI Host templates to add vSAN capacity. These represent the hosts that add storage capacity to a vSAN cluster. For more information, see [HCI Host Template Settings](#).

Under certain circumstances, *Add Virtual Machines* plans can fail to place workloads, or it can fail to generate actions to increase storage capacity by provisioning new hosts.













- If you scope the plan to a user-created group that only provides vSAN storage, or to a discovered storage cluster group, then the plan can fail to place VMs with multiple volumes. This can occur for VMs that use conventional storage (not vSAN) along with vSAN storage.
- If you scope the plan to a vSAN host group and add VMs, the plan can fail to increase storage capacity by provisioning new hosts. For example, assume you scope the plan to a vSAN host group and add 20 VMs to the environment. In that case, you need hosts to provide compute capacity for the VMs, and you also need hosts to provide storage capacity. The plan can represent the compute provisioning correctly, but it can incorrectly fail to add more storage capacity to the vSAN.
- If the vSAN RAID type is Raid6/FTT=2, if you scope the plan to any vSAN groups then the plan will fail to place any of the VMs.

Storage Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

The following are the storage actions and automation support for environments that do not include Disk Array Storage Controllers as targets. For details about these actions, see [Storage Actions](#).

Action	Default Mode	vCenter	Hyper-V
Delete (Volume)	Recommend		
Suspend	Manual		
Delete (Datastore)	Disabled		
Move	Recommend		
Provision	Recommend		
Start	Recommend		

Action	Default Mode	vCenter	Hyper-V
Resize (Up, Down, Above Max, or Below Min - using tuned scaling)	Recommend	Rcmd	Rcmd

For datastores on disk arrays:

Action	Default Mode	Dell Compellent	HP 3Par	NetApp ONTAP	VNX	VMAX	Nutanix	Pure Storage
Delete (Volume)	Recommend	Rcmd	Not supported	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd
Suspend	Manual	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd
Delete (Datastore)	Disabled	Rcmd	Not supported	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd
Move	Recommend	Rcmd	Not supported	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd
Provision	Recommend	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd
Start	Recommend	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd
Resize (Up, Down, Above Max, or Below Min - using tuned scaling)	Recommend	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd

You can use Action Scripts for action orchestration.

For ServiceNow:

- Storage suspend and vSAN storage resize actions will not generate a CR.
- Currently Turbonomic can only execute a CR for storage provision actions on Pure and Dell Compellent storage.

Utilization Constraints

Utilization constraints affect the actions Turbonomic recommends as it manages your environment. Turbonomic recommends actions that avoid using these resources beyond the given settings. The values

you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity.

Attribute	Default Value
Storage Amount Utilization	90
IOPS Utilization	100
Latency Utilization	100

For example, setting 90 for Storage Amount Utilization means that Turbonomic considers 90% utilization of the physical storage to be 100% of capacity.

Storage Settings

Attribute	Default Setting/Value
Directories to Ignore	\\.dvsData.* .snapshot.* .vSphere-HA.* .naa.* .etc.* lost +found.*
Files to Ignore	Empty String
Storage Latency Capacity [ms]	100
Storage Overprovisioned Percentage	200
IOPS Capacity	50000

• Wasted Storage Management

You can make settings to control how Turbonomic tracks and reports on wasted storage in your environment. Wasted storage is any disk space devoted to files that are not required for operations of the devices or applications in your environment. Wasted storage may indicate opportunities for you to free up disk space, and provide more storage capacity to running VMs and applications.

Note:

It's possible that a single datastore can be managed by more than one instance of vCenter Server. Browsing over such a datastore can result in conflicting values for wasted storage in reports and in the Improve Overall Efficiency dashboard. You should not enable datastore browsing for a scope that includes such a datastore.

If there are groups of datastores you don't want to track for wasted storage, set the given scope and disable datastore browsing there. If you prefer not to use Turbonomic resources to track wasted storage, leave the global setting checked.

The settings for **Directories to Ignore** and **Files to Ignore** specify directories and files that Turbonomic will not consider when looking for wasted data storage space. Separate items in these lists with the OR bar ("|").

• Storage Latency Capacity

This sets the maximum storage latency to tolerate on a datastore, in ms. The default setting is 100 ms.

Turbonomic measures the latency experienced by all VMs and hosts that access the datastore. Assume a default setting of 100 ms. If a datastore exhibits latency of 50 ms, then the Turbonomic will show latency utilization of 50%.

For VMAX environments, Turbonomic discovers SLO for storage latency that you set in VMAX and uses it in analysis. However, if you set a higher storage latency value in a Turbonomic policy, analysis will use that value instead.

- **Storage Overprovisioned Percentage**

Storage Overprovisioned Percentage sets how much overprovisioning Turbonomic assumes when recommending actions for VM datastores. For example, if a datastore has a 30 GB capacity, and Storage Overprovisioned Percentage is set to 200, Turbonomic will treat the datastore as though it has a capacity of 60 GB, or 200% of the actual datastore capacity.

- **IOPS Capacity**

IOPS Capacity is the IOPS setting for individual datastores. To set a specific capacity for one group of datastores, select that group as the property scope and override the global setting for that scope.

Note that IOPS capacity for a disk array takes precedence — Datastores that are members of a disk array always have the IOPS capacity that is set to the disk array.

Turbonomic considers these settings when calculating utilization percentage. For example, assume IOPS Capacity of 500 for datastores. If utilization on a datastore is 250 IOPS, then the datastore is at 50% of capacity for that metric.

Scaling Constraints

Rate of Resize

Turbonomic uses the Rate of Resize setting to determine how to make storage resize changes in a single action.

Attribute	Default Value
Rate of Resize	High (3)

- **Low**

Change the value by one increment only.

- **Medium**

Change the value by an increment that is 1/4 of the difference between the current value and the optimal value.

- **High**

Change the value to be the optimal value.

This default value ensures that resizing to the desired state can be achieved in a single action. This is more efficient than smaller, incremental resizes.

Increment Constant for Storage Amount

This setting controls how many GB to add or subtract when resizing the allocation for a datastore.

Attribute	Default Value
Increment Constant for Storage Amount [GB]	100 GB

Hyperconverged Infrastructure Settings

Turbonomic considers these settings when calculating capacity and utilization for hyperconverged environments.

Attribute	Default Setting/Value
Host Capacity Reservation	1
Host IOPS Capacity	50000
Slack Space Percentage	25
Compression Ratio	1
Usable Space Includes Compression	Off

Note:

Turbonomic uses Host Capacity Reservation, Slack Space Percentage, and Compression Ratio to calculate vSAN usable capacity and drive scaling actions. For more information about usable capacity and how it is calculated, see [vSAN Storage](#).

- **Host Capacity Reservation**

When a host must be taken out of service for maintenance, vSphere will evacuate the data from that host and move it to other hosts in the cluster to maintain the integrity of the replication demanded by the storage policy. For this to happen, there must be enough free raw capacity available to accept the data being evacuated.

Turbonomic uses this setting to determine how many hosts worth of capacity it should subtract from the raw capacity amount before calculating usable capacity. This is not the same as redundancy. It does not specify how the array distributes data to maintain integrity.

- **Host IOPS Capacity**

In addition to calculating usable capacity, Turbonomic needs an estimate of datastore IOPS capacity (storage access). Turbonomic uses the value that you set to provide an estimate of effective IOPS capacity for each host in the cluster. Total IOPS capacity is the number of hosts in the cluster multiplied by Host IOPS Capacity.

- **Slack Space Percentage**

It is recommended that a vSAN datastore never be filled to prevent vSphere from moving objects/files around the cluster to balance the datastore across all the hosts.

Turbonomic reduces usable capacity by the percentage that you set.

- **Compression Ratio**

vSAN supports both deduplication and compression, which may increase the amount of usable capacity on the datastore. Turbonomic does not try to predict the deduplication or compression ratio, but you can choose to include a compression ratio into the usable capacity calculation. This captures the ratio achieved both by compression and deduplication.

The compression ratio that you set acts as a multiplier on the raw capacity to calculate usable capacity. For example, a compression ratio of 2 would double the amount of usable capacity. The default value of 1 means no compression.

- **Usable Space Includes Compression**

Turn this on if you want Turbonomic to consider the compression ratio when calculating storage utilization and capacity. Whether this is on or off, Turbonomic always considers compression when calculating utilization of StorageProvisioned.

Placement Policies

Turbonomic supports placement policies for storage and storage clusters.

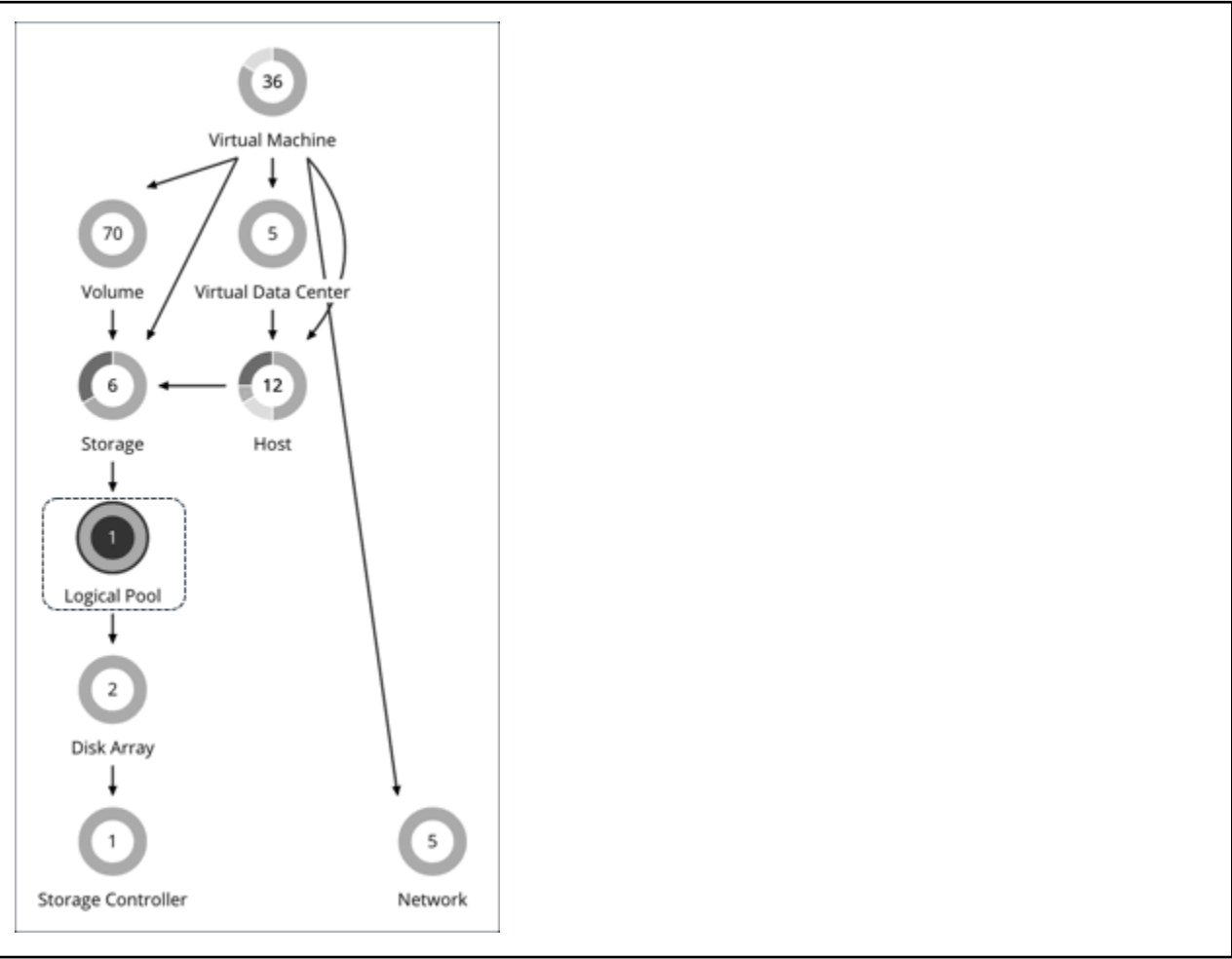
- You can create placement policies to enforce constraints for storage move actions. For example, you can have a policy that allows storage to only move to certain disk arrays, or a policy that prevents storage from moving to certain disk arrays.
- You can create placement policies that merge multiple clusters into a single logical group for the purpose of workload placement.

For more information, see [Creating Placement Policies](#).

Logical Pool

A logical pool represents storage resources that are managed together and presented as a single storage system. Turbonomic analysis identifies performance and efficiency opportunities for a logical pool. For example, it can recommend moving resources into or out of a logical pool, or aggregating resource capacity within the pool.

Synopsis



Synopsis	
Budget:	N/A
Provides:	Storage resources
Consumes:	Disk array resources
Discovered through:	Storage targets

Monitored Resources

Turbonomic monitors the following resources for a logical pool:

- Storage Amount
The utilization of the logical pool's capacity.
Measured in Megabytes (MB)
- Storage Provisioned
The utilization of the logical pool's capacity, including overprovisioning.
Measured in Megabytes (MB)
- Storage Access Operations Per Second (IOPS)
The summation of the read and write access operations per second on the logical pool.
Measured in Operations per second
- Latency
The utilization of latency on the logical pool.
Measured in milliseconds (ms)

Logical Pool Actions

- Resize
- Provision
- Move
- Start
- Suspend

Logical Pool Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

Action	Default Mode
Suspend	Disabled
Start	Disabled
Resize	Recommend
Move	Disabled
Provision	Disabled

Storage Settings

Attribute	Default Value
Storage Latency Capacity [ms]	100
Storage Overprovisioned Percentage	200
IOPS Capacity	50000

- **Storage Latency Capacity**

This sets the maximum storage latency to tolerate on a logical pool, in ms. The default setting is 100 ms.

- **Storage Overprovisioned Percentage**

Storage Overprovisioned Percentage sets how much overprovisioning Turbonomic assumes when recommending actions for logical pools.

- **IOPS Capacity**

IOPS Capacity is the IOPS setting for individual logical pools.

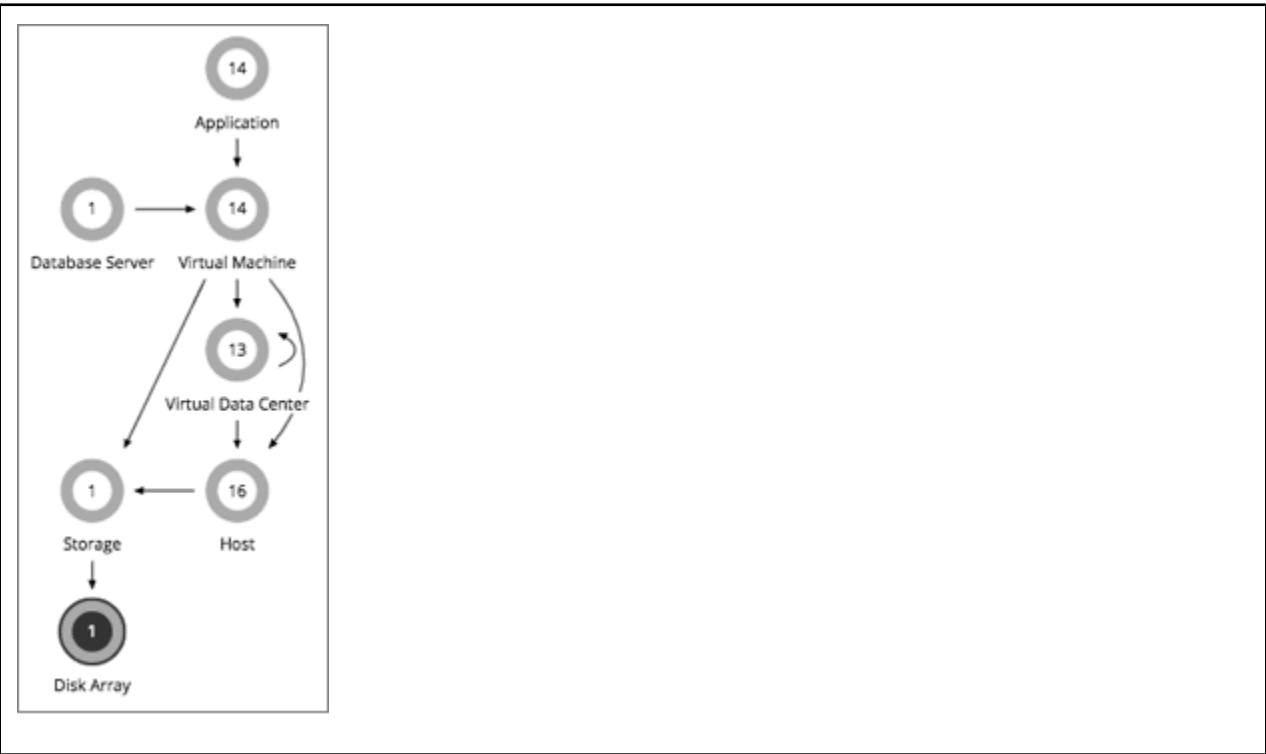
Note:

Turbonomic discovers storage latency and IOPS capacities that you set in your environment (for example VMAX) and uses them in its analysis. These capacities will be overridden by values that you set in Turbonomic policies.

Disk Array

A Disk Array (an aggregate) is a data storage system made up of multiple disk drives. For example, a RAID is an aggregate that implements redundancy and other data management features. A disk array provides storage volumes to serve the storage requirements of physical machines. It uses the resources of one storage controller, which manages the disk array operation.

Synopsis



Synopsis	
Budget:	A disk array gains its budget by selling resources to the datastores it serves. If utilization of a disk array is high enough, Turbonomic can recommend that you provision a new one.
Provides:	Storage resources for datastores to use: <ul style="list-style-type: none">• Storage amount• Storage Provisioned• IOPS (storage access operations per second)• Latency (capacity for disk latency in ms)
Consumes:	Storage controllers
Discovered through:	Turbonomic discovers disk arrays through storage controller targets.

Monitored Resources

Turbonomic monitors the following resources for a disk array:

Note:

Not all targets of the same type provide all possible commodities. For example, some storage controllers do not expose CPU activity. When a metric is not collected, its widget in the UI will display no data.

- Storage Amount
The utilization of the Disk Array's capacity.
Measured in Megabytes (MB)
- Storage Provisioned

The utilization of the Disk Array's capacity, including overprovisioning.

Measured in Megabytes (MB)

- Storage Access Operations Per Second (IOPS)

The summation of the read and write access operations per second on the disk array

Measured in Operations per second

- Latency

The utilization of latency, computed from the latency of each device in the disk array.

Measured in milliseconds (ms)

Disk Array Actions

- **Provision**

For high utilization of the disk array's storage, provision a new disk array (recommendation, only).

- **Start**

For high utilization of disk array, start a suspended disk array (recommendation, only).

- **Suspend**

For low utilization of the disk array's storage, move VMs to other datastores and suspend volumes on the disk array (recommendation, only).

- **Move**

(Only for NetApp Cluster-Mode) For high utilization of Storage Controller resources, Turbonomic can move an aggregate to another storage controller. The storage controllers must be running.

For high IOPS or latency, a move is always off of the current disk array. All the volumes on a given disk array show the same IOPS and Latency, so moving to a volume on the same array would not fix these issues.

- **Move VM**

For high utilization of Storage on a volume, Turbonomic can move a VM to another volume. The new volume can be on the current disk array, on some other disk array, or on any other datastore.

For high IOPS or latency, a move is always off of the current disk array. All the volumes on a given disk array show the same IOPS and Latency, so moving to a volume on the same array would not fix these issues.

- **Move Datastore**

To balance utilization of disk array resources, Turbonomic can move a datastore to another array.

Disk Array Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

The following table describes the default action mode for disk array actions and automation support for environments that have Disk Array Storage Controllers as targets.

Action	Default Mode	Dell Compellent	HP 3Par	NetApp ONTAP	VMAX	VNX	Nutanix	Pure Storage	XTremIO
Move	Disabled			Rcmd					
Provision	Recommend	Rcmd	Rcmd	Rcmd			Rcmd		
Resize (up)	Recommend	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd		
Start	Recommend								
Suspend	Disabled								

Action Automation for NetApp Storage Systems

For NetApp storage systems, the actions Turbonomic can automatically perform depend on the NetApp version you are running, and whether the system is running in cluster mode:

Automated Action	Cluster-Mode
Move VM between datastores, on the same disk array	Yes
Move VM between datastores on different disk arrays	Yes
Move Datastore between disk arrays on the same storage controller	Yes
Move Datastore between disk arrays on different storage controllers	Yes
Resize Storage	Yes
Resize Disk Array	No — Resize up, only

In addition, for a system running in Cluster-Mode, Turbonomic can recommend moving an aggregate to another storage controller.

Utilization Constraints

Utilization constraints affect the actions Turbonomic recommends as it manages your environment. Turbonomic recommends actions that avoid using these resources beyond the given settings. The values you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity.

Attribute	Default Value
Storage Amount Utilization	90

Storage Settings

Set capacity for specific storage resources.

Attribute	Default Value
IOPS Capacity A generic setting for disk array IOPS capacity (see Disk Array IOPS Capacity below).	5000
VSeries LUN IOPS Capacity	5000
7.2k Disk IOPS Capacity	800
10k Disk IOPS Capacity	1200
15k Disk IOPS Capacity	1600
SSD Disk IOPS Capacity	50000
Disk Array IOPS Capacity	10000
Storage Overprovisioned Percentage	200
Storage Latency Capacity [ms]	100

Note:

Turbonomic discovers storage latency and IOPS capacities that you set in your environment (for example VMAX) and uses them in its analysis. These capacities will be overridden by values that you set in Turbonomic policies.

• **IOPS Capacity**

The capacity of IOPS (IO operations per second) that your storage devices can support. Turbonomic considers these settings when calculating utilization percentage. For example, assume IOPS Capacity of 5000 for a disk array. If utilization on the array is 2500 IOPS, then the disk array is at 50% of capacity for that metric.

Note that the IOPS setting for an array will determine IOPS calculations for all the storage on that array. If you made different IOPS settings for individual datastores hosted by the array, Turbonomic ignores the datastore settings and uses the disk array settings.

- Various Disk IOPS Capacity settings (**SSD Disk IOPS**, **7.2k Disk IOPS**, etc)

IOPS capacity settings for the different types of physical drives that are discovered on a disk array. If the storage controller exposes the types of disks in the array, Turbonomic uses multiples of these values to calculate the IOPS capacity of the disk array.

- **Disk Array IOPS Capacity**

Some disk arrays do not expose data for their individual disks — This is typical for flash arrays, or arrays that aggregate storage utilization across multiple tiers. Turbonomic uses this setting for the IOPS capacity of such disk arrays. Set it to the global scope to specify IOPS capacity for all disk arrays. To override this setting, set a disk array or group of disk arrays as the property scope, and then set the value you want for **IOPS Capacity**.

Note:

The user interface shows a disk array entity for any array that is discovered through a valid disk array or storage controller target. It also shows *placeholder* disk arrays for disk arrays that are not discovered through a configured target. For example, you might have disk arrays that Turbonomic does not natively support. Or you might have storage that is not hosted by any disk array. Such *placeholder* disk array entities appear with the string "DiskArray-" prefixed to their names. The user interface allows you to set IOPS Capacity to these placeholders, but those settings have no effect. To set IOPS Capacity for that storage, you must set it to the individual datastores.

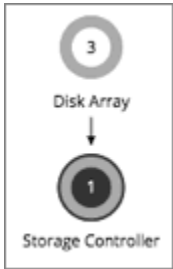
- **Storage Overprovisioned**

This setting indicates how much overprovisioning Turbonomic assumes when recommending actions for disk arrays. For example, if a disk array has a 30 TB capacity, and DiskArray Overprovisioned Percentage is set to 200, Turbonomic will treat the datastore as though it has a capacity of 60 TB, or 200% of the actual disk array capacity.

Storage Controller

A Storage Controller is a device that manages one or more disk arrays. The storage controller provides CPU cycles to perform storage management tasks for each disk array it manages.

Synopsis



Synopsis

Budget:	A storage controller gains its budget by selling resources to the disk arrays it manages. If utilization of the storage controller's CPU resources is high enough, Turbonomic can recommend that you provision a new one and move disk arrays (aggregates) to it.
Provides:	CPU resources to manage disk arrays.
Consumes:	NA
Discovered through:	Turbonomic directly accesses storage controller targets.

Monitored Resources

Turbonomic monitors the following resources for a storage controller:

- CPU

The utilization of the Storage Controller's allocated CPU

Measured in Megahertz (MHz)

- Storage Amount

The utilization of the storage controller's capacity. The storage allocated to a storage controller is the total of all the physical space available to aggregates managed by that storage controller.

Measured in Megabytes (MB)

Note:

In NetApp environments, the storage controller shows 100% utilization when there are no more disks in a SPARE state that the storage controller can utilize in an aggregate. This does not indicate that the storage controller has no capacity.

Actions

Provision

For high utilization of the storage controller's CPU, provision a new storage controller, and then move disk arrays to it.

Storage Controller Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

Actions for individual Disk Array Storage Controllers:

Action	Default Mode	Dell Compellent	HP 3Par	NetApp ONTAP	VNX	VMAX	Nutanix	Pure Storage	XTremIO
Provision	Disabled	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd	Rcmd

Utilization Constraints

Utilization constraints affect the actions Turbonomic recommends as it manages your environment. Turbonomic recommends actions that avoid using these resources beyond the given settings. The values you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity.

Attribute	Default Value
Storage Amount Utilization	90 Maximum allowed utilization of storage that is managed by the Storage Controller.
CPU Utilization	100 Maximum allowed utilization of Storage Controller CPU (from 20 to 100).

Storage Settings

Set capacity for specific storage resources.

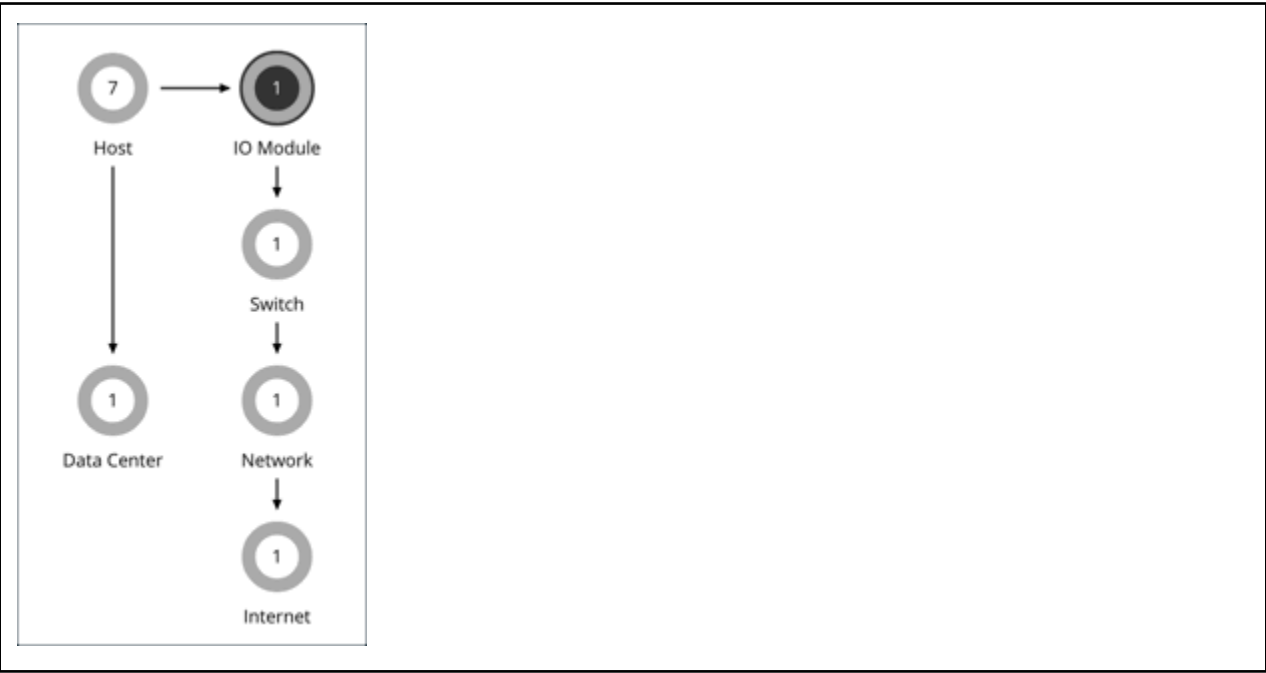
Attribute	Default Value
IOPS Capacity	5000
Storage Latency Capacity [ms]	100

IO Module

An IO Module connects the compute resources on a chassis to the fabric domain via the Fabric Interconnect. It provides the servers on the chassis with Net resources. Typical installations provide two IO Modules per chassis.

Turbonomic supports IO Modules when you have installed the Fabric Control Module license.

Synopsis



Synopsis	
Budget:	An IO Module gains its budget by selling Net resources to a physical machine.
Provides:	Net resources
Consumes:	Chassis and Fabric Interconnect
Discovered through:	Turbonomic discovers IO Modules through the fabric managers that use them.

Monitored Resources

Turbonomic monitors the following resources for an IO Module:

- NetThroughput
 - Rate of message delivery over a port
 - Measured in Megabits per second (Mb/s)

Actions

None

Turbonomic does not recommend actions for an IO Module.

Switch

A switch connects servers in a computing fabric to the fabric’s network and storage resources. It provides network bandwidth to the servers in the platform.

Synopsis



Synopsis	
Budget:	A switch gains its budget by selling Net resources to the IO Modules.
Provides:	Net resources
Consumes:	N/A
Discovered through:	Turbonomic discovers switches through managers of fabric platforms (such as UCS) that use them.

Monitored Resources

Turbonomic monitors the following resources for a switch:

- NetThroughput
Rate of message delivery over a port
Measured in Mb/s
- PortChannel
Amalgamation of ports with a shared net throughput and utilization
Measured in Mb/s

Actions

Resize






Resize PortChannel for a switch to increase bandwidth.

Switch Policies

Turbonomic ships with default settings that we believe will give you the best results from our analysis. These settings are specified in a set of default automation policies for each type of entity in your environment. For some scopes of your environment, you might want to change these settings. For example, you might want to change *action automation* or *constraints* for that scope. You can create policies that override the defaults for the scopes you specify.

Action Automation and Orchestration

For environments that have Fabric Managers as targets:

Action	Default Mode	Cisco UCS
Resize	Recommend	
Start	Recommend	
Provision	Recommend	
Suspend	Disabled	
Move	Disabled	

Utilization Constraints

Utilization constraints affect the actions Turbonomic recommends as it manages your environment. Turbonomic recommends actions that avoid using these resources beyond the given settings. The values you set here specify what percentage of the existing capacity that Turbonomic will consider to be 100% of capacity.

Attribute	Default Value
Switch Net Throughput	70

Plans: Looking to the Future

The screenshot displays the Turbonomic Plan Page. At the top, there's a header with a '+ Add Workload 14' button and a 'SCOPE' dropdown set to 'DC14\DC14-Cluster'. Below this is a toolbar with icons for Add, Replace, Remove, Actions, Ignore Constraints, Placement Policies, Utilization, Baseline, Desired State, and Projection. The main content is split into two panels. The left panel, titled 'CONFIGURATION', shows settings for 'Add Virtual Machines from 1 Account' (Product Trust), 'Max Host Utilization Level' (80%), 'Hosts Action Settings' (Provision for Hosts enabled, Suspend for Hosts enabled), and 'Virtual Machines Action Settings' (Scale for Virtual Machines enabled). The right panel, titled 'RESULTS OVERVIEW PLAN ACTIONS (170)', shows a 'Plan Summary' table comparing current and after-plan states for various resources.

	Current	After Plan	Difference	%
Virtual Machines	30	30	0	0 %
Hosts	3	15	12	▲ 400 %
Storage	6	14	8	▲ 133.3 %
CPU	6 Cores	32 Cores	26	▲ 433.3 %
Memory	12 GB	246.5 GB	234.5 GB	▲ 1958.3 %
Storage Amount	3.6 GB	6.3 GB	2.7 GB	▲ 50 %
Host Density	10:1	2:1	8:1	▼ 80 %
Storage Density	5:1	2:1	3:1	▼ 60 %

Use the Plan Page to run simulations for what-if scenarios that explore possibilities such as:

- Reducing cost while assuring performance for your workloads
- Impact of scaling resources
- Changing hardware supply
- Projected infrastructure requirements
- Optimal workload distribution to meet historical peaks demands
- Optimal workload distribution across existing resources

How Plans Work

To run a plan scenario, Turbonomic creates a snapshot copy of your real-time market and modifies that snapshot according to the scenario. It then uses the Economic Scheduling Engine to perform analysis on that plan market. A scenario can modify the snapshot market by changing the workload, adding or removing hardware resources, or eliminating constraints such as cluster boundaries or placement policies.

As it runs a plan, Turbonomic continuously analyzes the plan market until it arrives at the optimal conditions that market can achieve. When it reaches that point, the Economic Scheduling Engine cannot find better prices for any of the resources demanded by the workload — the plan stops running, and it displays the results as the plan's desired state. The display includes the resulting workload distribution across hosts and datastores, as well as a list of actions the plan executed to achieve the desired result.

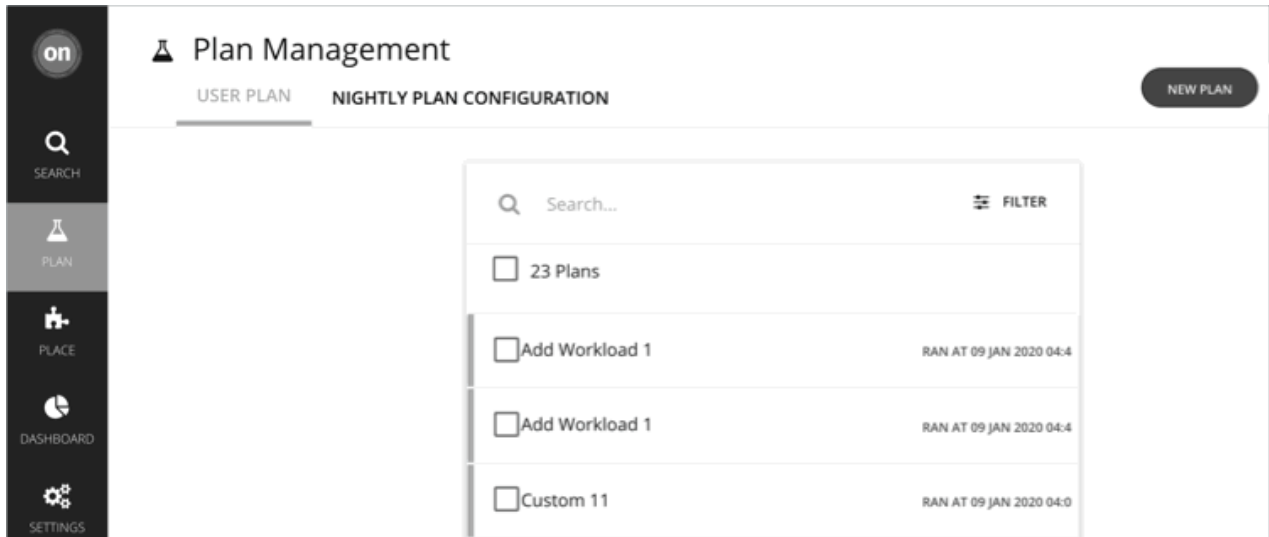
For example, assume a scenario that adds virtual machines to a cluster. To run the plan, Turbonomic takes a snapshot of the current market, and adds the VMs to the specified cluster. Turbonomic then runs analysis on the plan market, where each entity in the supply chain shops for the resources it needs, always looking for a better price — looking for those resources from less-utilized suppliers. This analysis continues until all the resources are provided at the best possible price.

The results might show that you can add more workload to your environment, even if you reduce compute resources by suspending physical machines. The recommended actions would then indicate which hosts you can take offline, and how to distribute your virtual machines among the remaining hosts.

Idle Workloads

Plans calculate optimal placement and optimal resource allocation for the given workload. However, plans do not include *idle* workloads. This is because an idle VM shows no utilization, so the plan cannot determine optimal placement or what percentage of allocated resources that workload will require when it restarts.

Plan Management



The Plan Management Page is your starting point for creating new plans, viewing saved plans, and deleting saved plans that you don't need anymore. To display this page, click **Plan** in the Turbonomic navigation bar.

- Create new plans

To create a new plan, click the **NEW PLAN** button. See [Setting Up Plan Scenarios](#).

- View saved plans

After you create and run a plan, Turbonomic saves it and then shows it in the Plan Management Page. You can open the saved plan to review the results, or you can change its configuration and run it again.

Note:

You can also view saved plans from the Search page, under the **Plans** category.

- Delete saved plans

To delete a saved plan, turn on the plan's checkbox and then click the **Delete** button.

- Configure nightly plans

Turbonomic runs nightly plans to calculate headroom for the clusters in your on-prem environment. For each cluster plan, you can set which VM template to use in these calculations. See [Configuring Nightly Plans](#).

Setting Up Plan Scenarios

A plan scenario specifies the overall configuration of a plan. Creating the plan scenario is how you set up a what-if scenario to see the results you would get if you changed your environment in some way.

This topic walks you through the general process of setting up a plan scenario.

1. Plan Entry Points

You can begin creating a plan scenario from different places in the user interface:

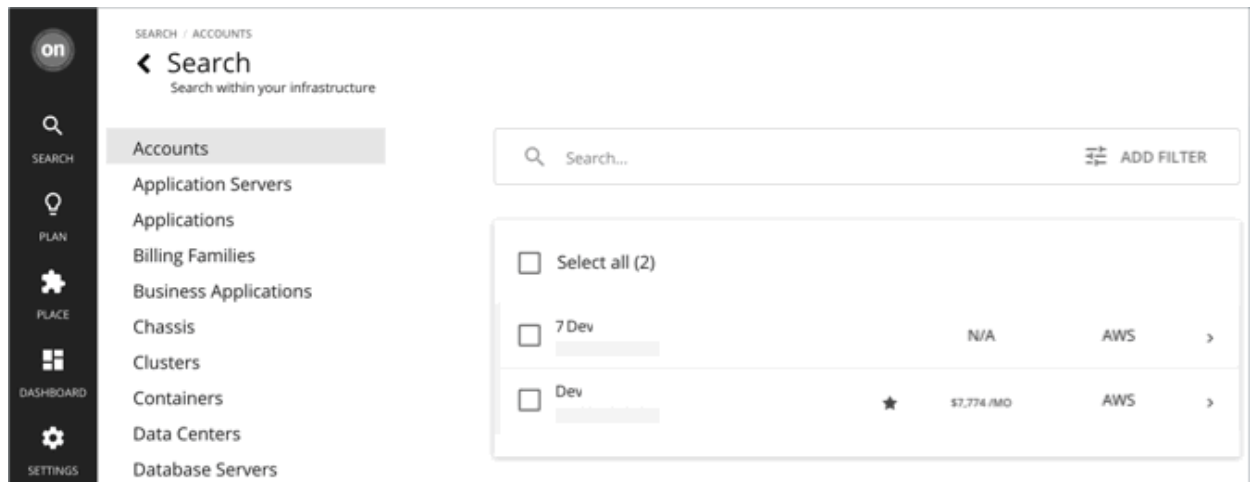
- From the Plan Page

Navigate to the Plan Page and click **NEW PLAN**. This plan has no scope. You will specify the scope after selecting the plan type.



- From the **Home Page**

To start a plan scenario from the **Home Page**, you must first go to the **Search** page to set the scope.



- Cloud scope

If you set the scope to *a specific* Account, Billing Family, VM Group, or Region, you can start an Optimize Cloud or Buy VM Reservations plan.

- On-prem scope

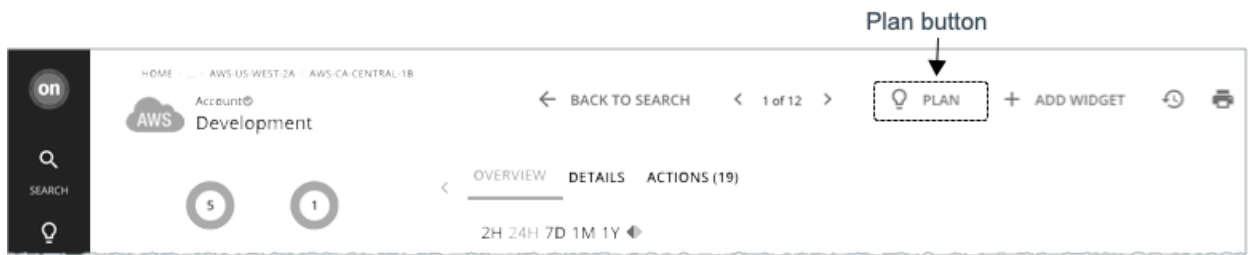
If you set the scope to *a specific* Cluster, Datacenter, Group, Storage Cluster, or Virtual Datacenter, you can start any plan. You may need to go through additional steps, depending on your chosen plan type. For example, if you scope to a cluster and choose the Add Virtual Machines plan type, the plan wizard prompts you to select the most suitable templates for the VMs you plan to add to the cluster.

- Container cluster scope

If you set the scope to *a specific* Container Platform Cluster, you can start an Optimize Container Cluster plan.

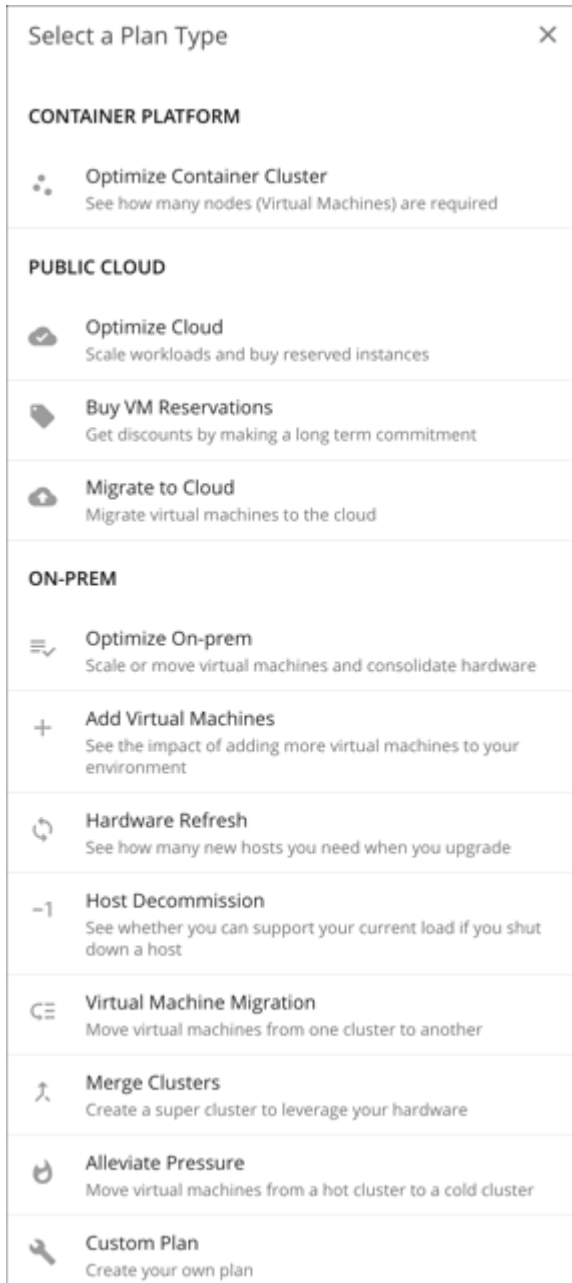
For details, see [Scoping the Turbonomic Session](#).

After setting the scope, the **Plan** button appears in the **Home Page**.



2. Plan Types

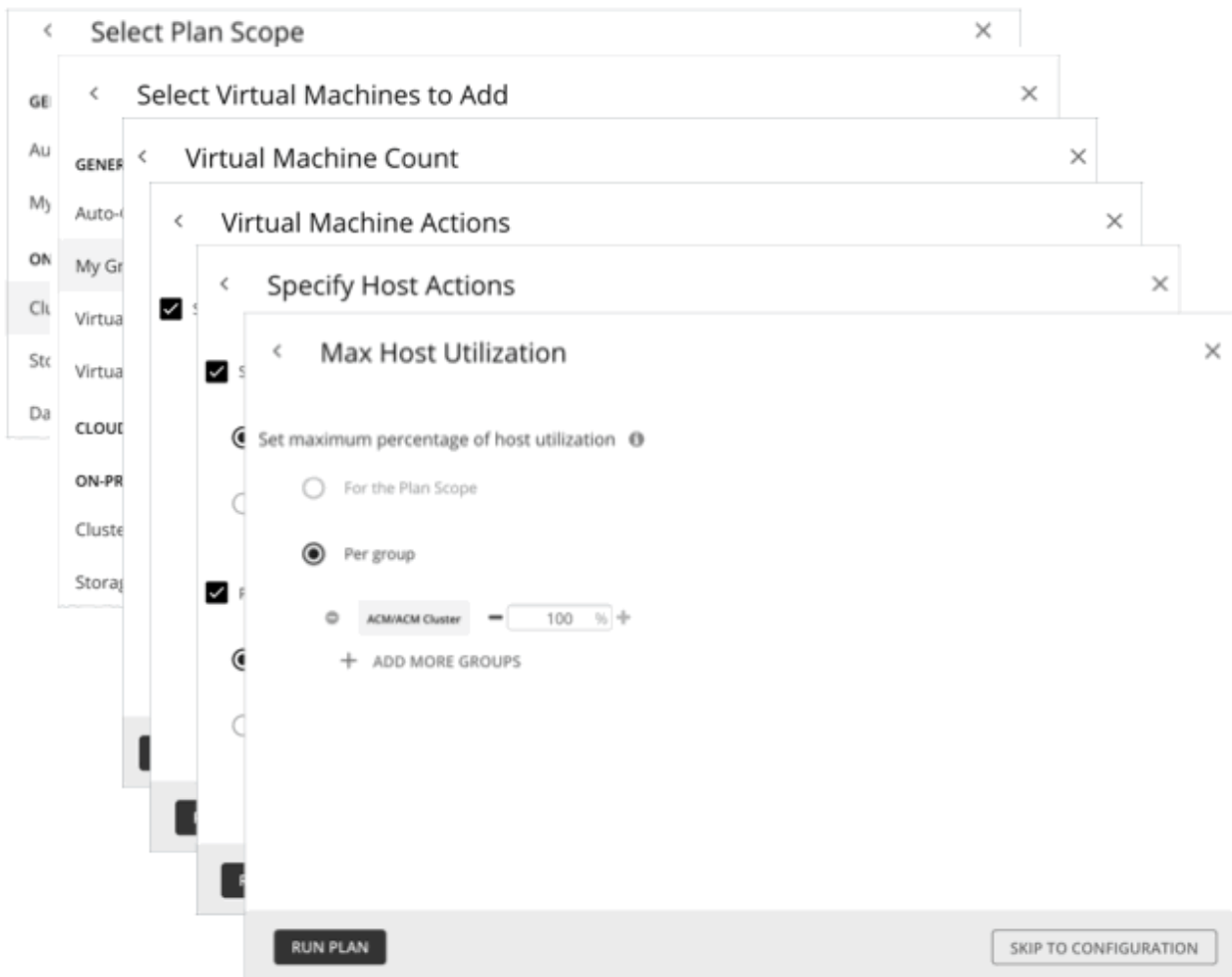
Select from the list of plan types. For more information, see [Plan Scenarios and Types](#).



Turbonomic opens the appropriate plan wizard.

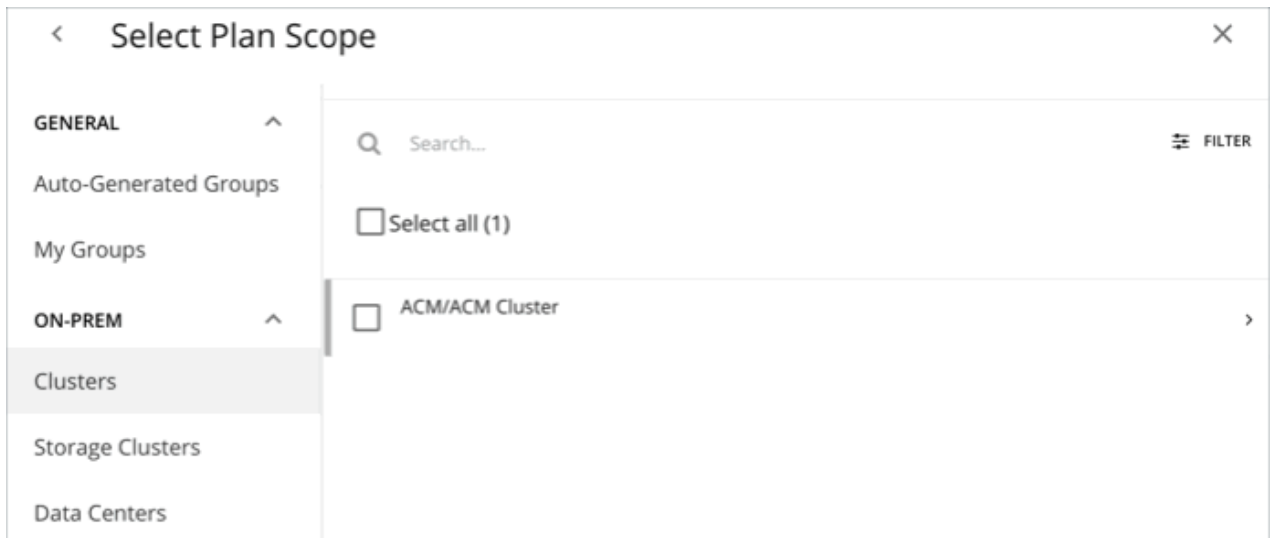
3. Plan Wizards

Each plan type includes a wizard to guide you through creating the scenario. The wizard leads you through the required configuration steps to create a plan that answers a specific question. After you make the required settings, you can skip ahead and run the plan, or continue through all the optional steps.



4. Plan Scope

All plans require a scope. For example, to configure a Hardware Refresh plan, you set the scope to the hosts that you plan to replace.



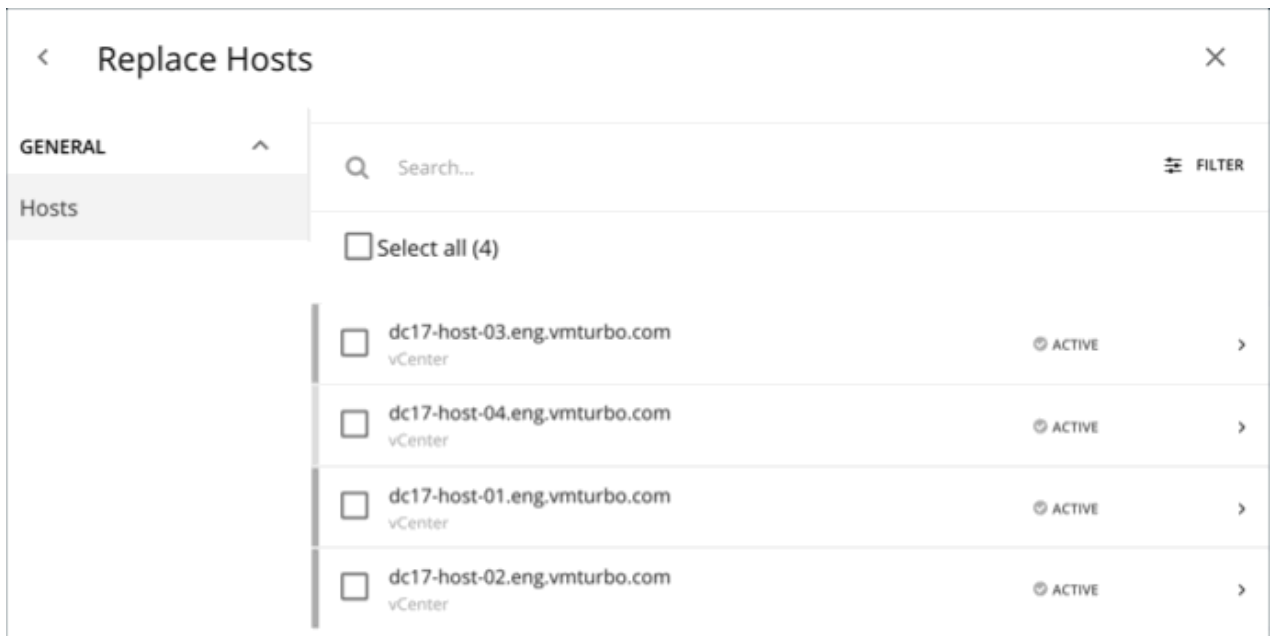
It usually helps to focus on a subset of your environment. For a very large environment, scoped plans run faster.

To narrow the scope, select a group from the list on the left side of the page. The page then refreshes to include only the entities belonging to that group.

Use **Search** or **Filter** to sort through a long list.

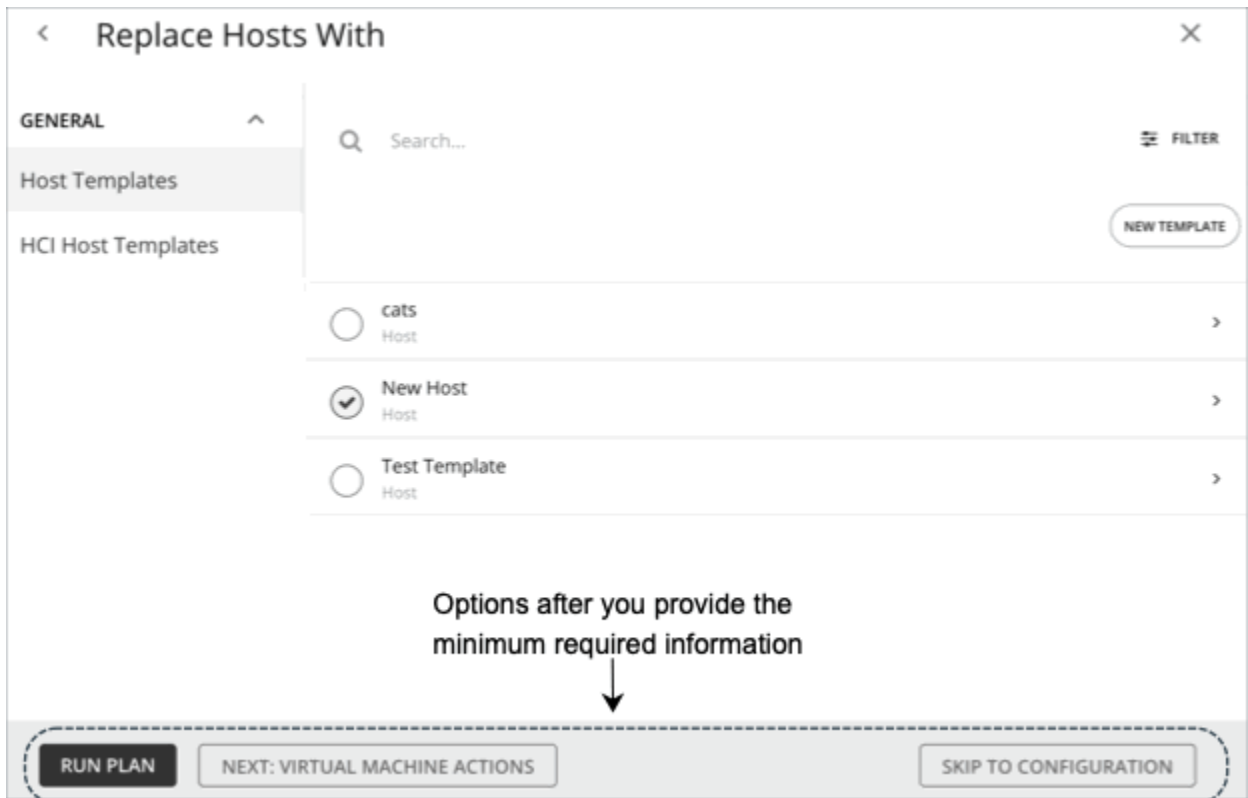
5. Additional Plan Information

The wizard prompts you for any additional information required to run the plan. For example, for a Hardware Refresh plan, you need to identify the hosts that will replace the scoped hosts.



6. Run the Plan

After you provide the minimum required information for running a plan, the wizard shows you the following options:



- **Run Plan:** Immediately run the plan.
- **Next: [Step]:** Continue with the rest of the wizard and then run the plan.
- **Skip to Configuration:** Skip the rest of the wizard and go to the Plan Page to:
 - Customize the plan settings.
 - See a preview of the plan scenario.
 - Run the plan.

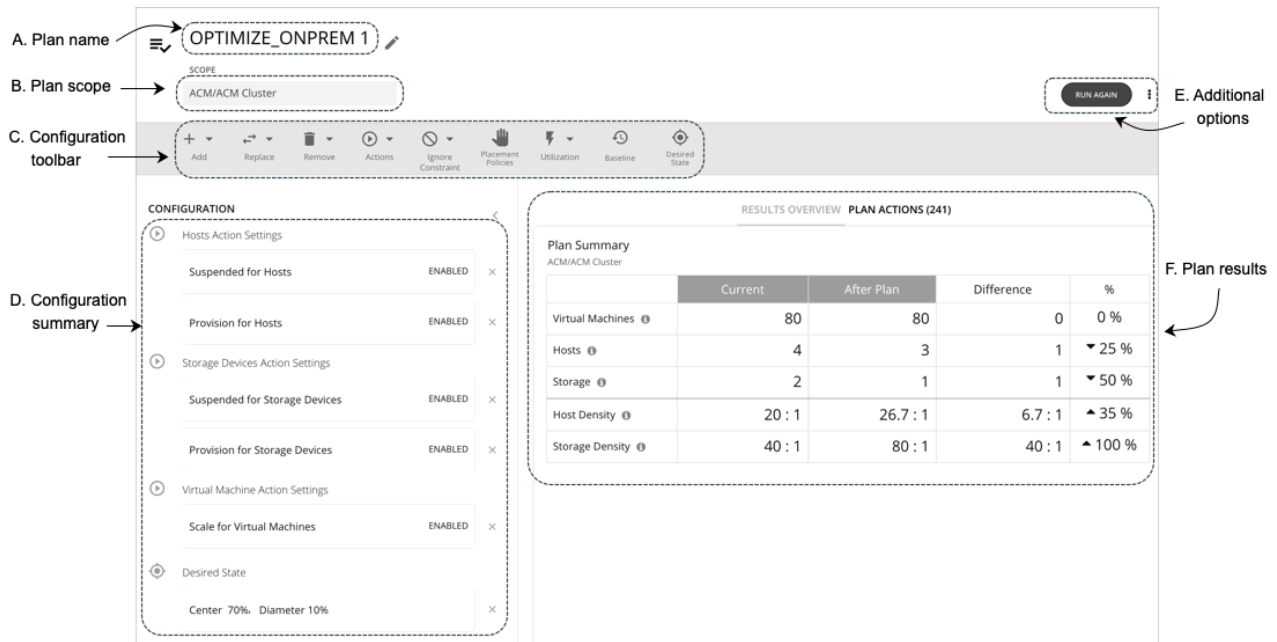
Note: For a custom plan, the only option available is **Configure Plan**. Click this button to open the Plan Page, configure the plan settings, and then run the plan.


7. The Plan Page


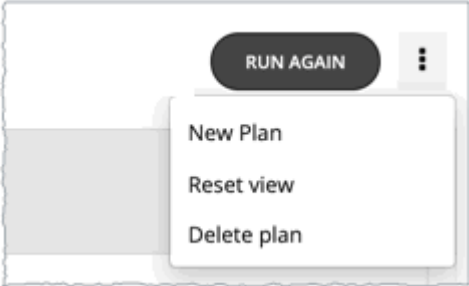
The Plan Page first displays if you skip the wizard or as soon as you run a plan.

For a plan with a large scope, it might take some time before you see the results. You can navigate away from the Plan Page and check the status in the Plan Management Page. You can also cancel a plan that is in progress.

The Plan Page shows the following sections:



Plan Page Sections	Description
A. Plan name	Turbonomic automatically generates a name when you create a new plan. Change the name to something that helps you recognize the purpose of this plan.
B. Plan scope	Review the scope that you set in a previous step. Note: It is not possible to change the scope of the plan in the Plan Page. You will need to start over if you want a different scope. To start over, go to the top-right section of the page, click the More options icon (), and then select New Plan .
C. Configuration toolbar	Configure additional settings for the plan. You can name the plan, change workload demand and the supply of resources, and specify other changes to the plan market. The toolbar items that display depend on the plan you are creating.
D. Configuration summary	Review the plan's configuration settings. You can remove any setting by clicking the x mark on the right. Use the toolbar on top to change the settings. As you make changes to the plan scenario, those changes immediately appear in the Configuration summary.

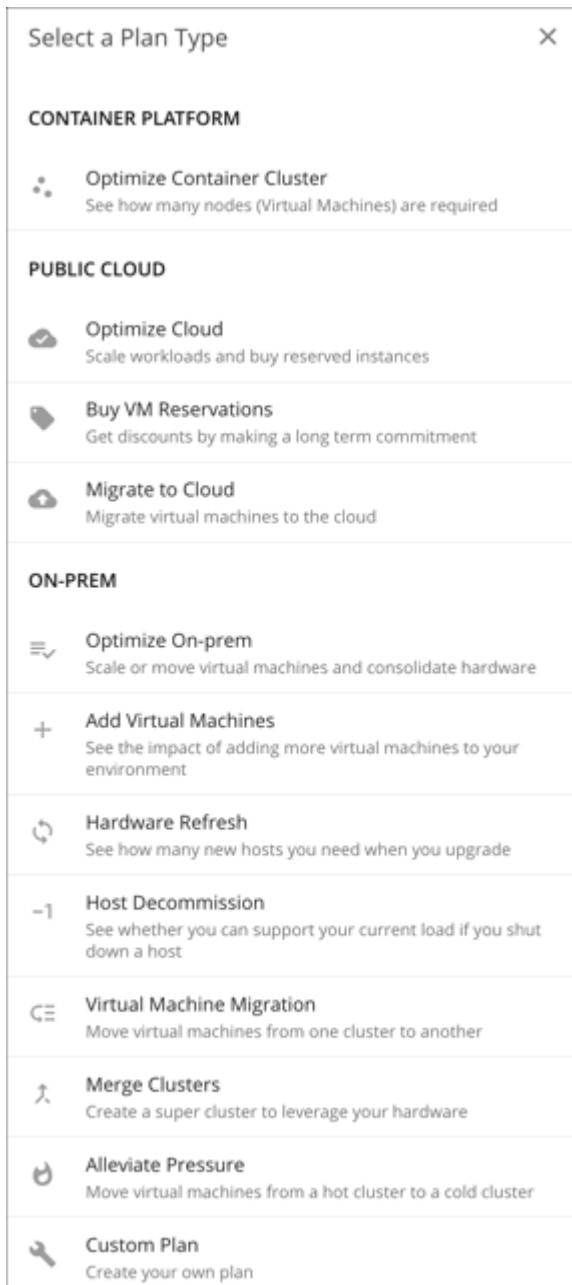
Plan Page Sections	Description
E. Additional options	<p>See what else you can do with the plan.</p> <ul style="list-style-type: none"> • Run / Run Again: <ul style="list-style-type: none"> – If a plan has not run, click Run and then check the plan results. – If the plan has run and you want to run it again with a different set of configuration settings, click Run Again. This runs the plan scenario against the market in its current state. •  : Click to see more options.  <ul style="list-style-type: none"> – New Plan: Configure a new plan. You can choose this option if you want to change the scope of the current plan, which requires that you start over and configure a new plan. – Reset view: Restore charts to their default views. For example, if you changed the commodities displayed in the Optimized Improvements or Comparison charts, you can discard those changes by choosing this option. – Delete plan: Choose if you no longer need the plan.
F. Plan results	<p>Review the results in the charts provided.</p> <p>For a plan that has not run, you will see a Scope Preview chart and a one-time message instructing you to run the plan.</p>

8. Plan Management

All the plans you have created display in the [Plan Management Page](#).

Plan Scenarios and Types

To simulate different plan scenarios, Turbonomic provides the following general types of plans:



Optimize Container Cluster

Run an Optimize Container Cluster plan to identify performance and efficiency opportunities for a single Kubernetes cluster. The results show the optimal number of nodes you need to assure performance for your existing workloads, and the impact of actions on the health of your container workloads and infrastructure.

Optimize Cloud

For the scope of your public cloud environment that you want to examine, run a plan to see all the opportunities you have to reduce cost while assuring performance for your workloads. This includes suggestions to buy RIs, comparisons of template and storage usage, and a comparison of current to optimized cost.

Buy VM Reservations

Run the Buy VM Reservations plan to see the most cost-effective RI purchases that will continue to assure performance for your cloud VMs.

Migrate to Cloud

A Migrate to Cloud plan simulates migration of on-prem VMs to the cloud, or migration of VMs from one cloud provider to another.

Note:

For migrations within your on-prem environment, use the *Virtual Machine Migration* plan type.

Optimize On-prem

See the effects of executing certain actions, such as scaling virtual machines, suspending hosts, or provisioning storage, to your on-prem environment.

Add Virtual Machines

Adding virtual machines increases the demand that you place on your environment's infrastructure. You can set up a plan to add individual VMs or groups of VMs in your environment, or based on templates.

Hardware Refresh

Choose hosts that you want to replace with different hardware. For example, assume you are planning to upgrade the hosts in a cluster. How many do you need to deploy, and still assure performance of your applications? Create templates to represent the upgraded hosts and let the plan figure out how many hosts you really need.

Host Decommission

If your environment includes underutilized hardware, you can use a plan to see whether you can decommission hosts without affecting the workloads that depend on them.

Virtual Machine Migration

Use this plan type to simulate workload migrations within your on-prem environment.

You can see whether you have enough resources to move your workload from its current provider group to another. For example, assume you want to decommission one datacenter and move all its workload to a different datacenter. Does the target datacenter have enough physical resources to support the workload move? Where should that workload be placed? How can you calculate the effect such a change would have on your overall infrastructure?

To calculate this information, create a plan that:

- Limits the plan scope to two datacenters (or clusters) — the one you will decommission, and the one that will take on the extra workload
- Removes all the hardware from the decommissioned datacenter
- Calculates workload placement across datacenter (or cluster) boundaries
- Does not provision new hardware to support the workload

Merge Clusters

See the effects of merging two or more clusters. For example, you can see if merging the clusters would require provisioning additional storage to support current demand, or if ignoring cluster boundaries would improve performance and efficiency.

Alleviate Pressure

Choose a cluster that shows bottlenecks or other risks to performance, and check to see the minimal changes you can make by migrating some workloads to another cluster. The cluster that is showing risks is a *hot* cluster, and the cluster you will migrate to is a *cold* cluster.

Custom Plan

With a custom plan, you skip directly to the plan configuration after specifying the plan scope, and set up whatever type of scenario you want.

You would also choose **Custom Plan** if you need to run plans that include containers and container pods.

Optimize Container Cluster Plan

The screenshot displays the 'Optimize Container Cluster 1' interface. On the left, the 'CONFIGURATION' panel shows settings for Container Spec, Container Pod, and Virtual Machines actions, all of which are 'ENABLED'. On the right, the 'RESULTS OVERVIEW' tab is active, showing a table titled 'Optimize Container Cluster Summary' for the 'Kubernetes-PT-AKS' cluster. The table compares current and planned states across various metrics, including Container Pods, Virtual Machines, Pod Density, and cluster capacity/overcommitment. A 'SHOW ALL' link is at the bottom right of the table.

	Current	After Plan	Difference	%
Container Pods	118	113	5	▼ 4.2 %
Virtual Machines	8	7	1	▼ 12.5 %
Pod Density	14.8 : 1	16.1 : 1	1.3 : 1	▲ 8.8 %
Cluster CPU Capacity	20 Cores	22 Cores	2 Cores	▲ 10 %
Cluster Memory Capacity	74 GB	82.9 GB	8.9 GB	▲ 12.1 %
Cluster Allocatable CPU	19.2 Cores	21.1 Cores	2 Cores	▲ 10.3 %
Cluster Allocatable Memory	53.8 GB	62.6 GB	8.8 GB	▲ 16.4 %
Cluster CPU Overcommitment	261 %	223.2 %	37.8 %	▼ 14.5 %
Cluster Memory Overcommitment	83.7 %	45.4 %	38.3 %	▼ 45.8 %

Run an Optimize Container Cluster plan to identify performance and efficiency opportunities for a single Kubernetes cluster. The results show the optimal number of nodes you need to assure performance for your existing workloads, and the impact of actions on the health of your container workloads and infrastructure. For example, you can see how container resize actions change the limits and requests allocated per namespace, or how node provision/suspend actions impact allocatable capacity for the cluster. For a cluster in the public cloud, the results also include the cost impact of node actions.

You can scope the plan to a:

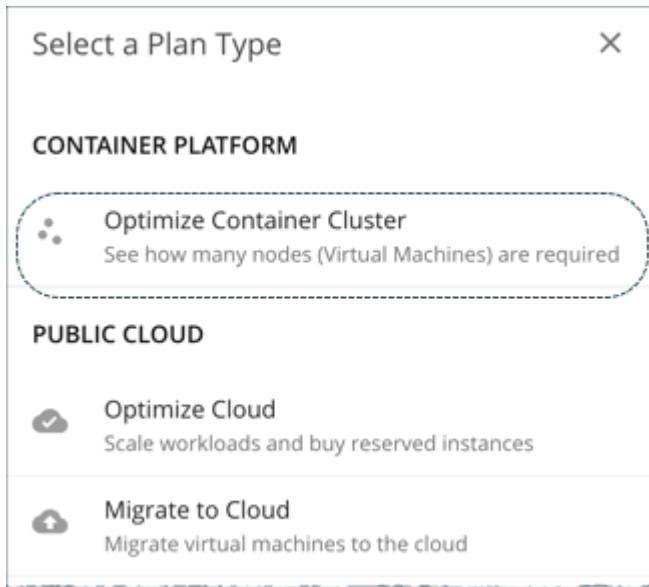
- Standalone container cluster
- Container cluster in an on-prem or public cloud environment
- Container cluster stitched to applications via Data Ingestion Framework (DIF)

Scoping to a group within a Kubernetes cluster (such as a group of nodes) is currently not supported.

Configuring an Optimize Container Cluster Plan

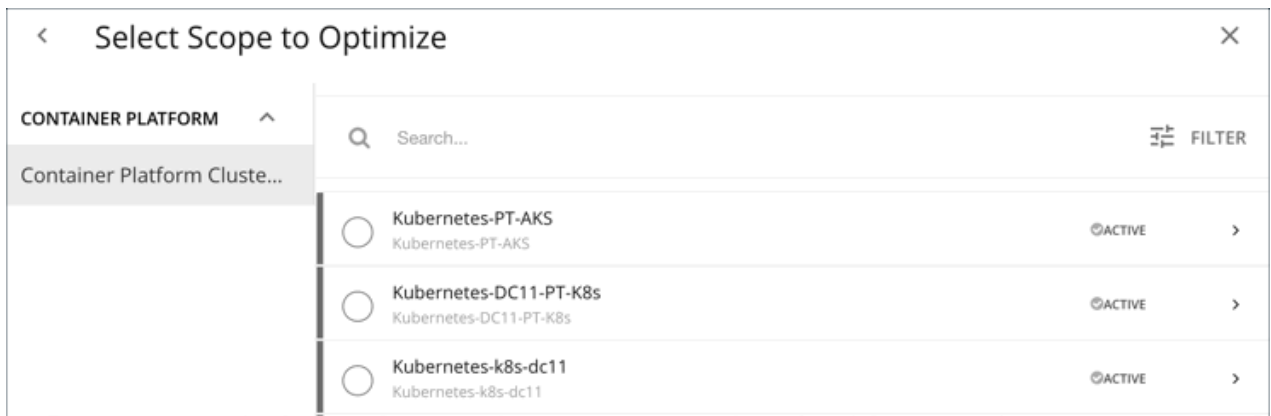
You can start an Optimize Container Cluster plan when you open the Plan page or set the scope to a Kubernetes cluster.

For an overview of setting up plan scenarios, see [Setting Up Plan Scenarios](#).



1. Scope

Select a Kubernetes cluster to optimize.



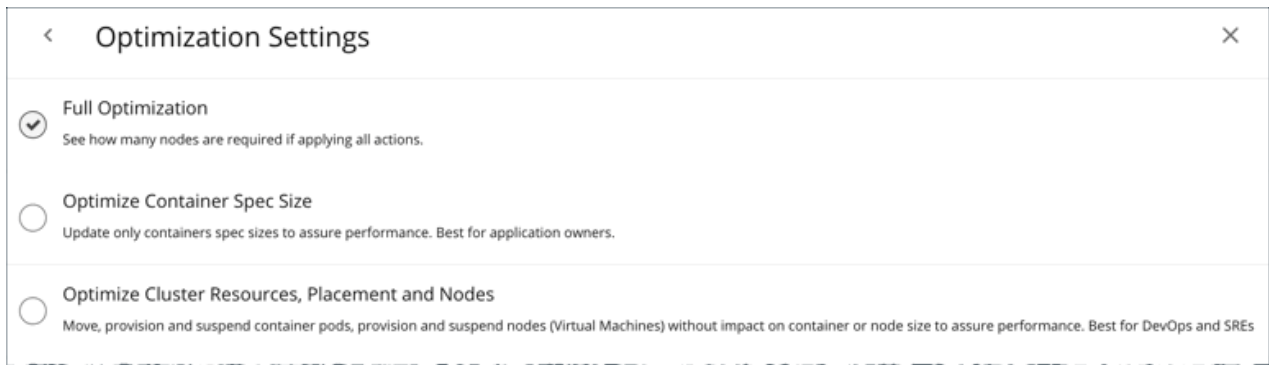
Scoping to a group within a Kubernetes cluster (such as a group of nodes) is currently not supported.

Note:

After selecting a cluster, you can skip the next step (**Optimization Settings**) and run the plan. Turbonomic runs the **Full Optimization** scenario in this case.

2. Optimization Settings

Choose from the given optimization scenarios.



- **Full Optimization**

Turbonomic will recommend all relevant actions to optimize the cluster. For example, it can recommend provisioning nodes or resizing containers to meet application demand, or moving pods from one node to another to reduce congestion.

Turbonomic can recommend the following actions:

- Resize namespace compute resource quotas
- Resize container limits and requests
- Move pods
- Provision or suspend nodes
- Scale volumes

Note:

For a cluster in the public cloud, Turbonomic shows the cost impact of actions on nodes and volumes, to help you track your cloud spend. Turbonomic only reports the costs attached to these actions, and does *not* perform cost analysis on the cluster.

For a cluster in an on-prem environment, Turbonomic can also recommend the following actions:

- Move VMs
- Provision or suspend hosts
- Provision or suspend storage

- **Optimize Container Spec Size**

Turbonomic will only recommend resizing container limits and requests. This is ideal for application owners who manage the containers that their applications run on, but not the underlying container infrastructure.

- **Optimize Cluster Resources, Placement, and Nodes**

Turbonomic will recommend *all* relevant actions, *except* resizing container limits and requests. This is ideal for teams who oversee the health of your container infrastructure, and want to evaluate the impact of *not* rightsizing workloads.

After selecting an optimization scenario, you can:

- Run the plan.
- Or
- Choose **Skip to Configuration** to configure additional settings. See the next section for details.

(Optional) Additional Plan Settings

You can fine tune your selected optimization scenario or include additional scenarios before you run the plan.

- Enable or disable actions

Fine tune your optimization scenario by enabling or disabling actions for containers, pods, or nodes. For example, you may have selected **Full Optimization**, but only for containers, nodes, and pods that are allowed to move. In this case, you would disable move actions for the pods that should never move.

For clusters in on-prem environments, you can also enable or disable actions for hosts and storage.

Important:

To avoid seeing inaccurate plan results, do *not* disable all actions.

- Add pods

See resource changes if you add more pods to the cluster. For example, you might need to provision nodes to accommodate the new pods.

Select an existing pod within or outside the selected Kubernetes cluster, and then specify how many copies to add. The plan simulates adding pods with the same resources as the selected pod.

- Remove pods or nodes

See the effect of removing pods or nodes from the cluster. For example, pod density could improve significantly if you remove pods that you no longer need, or certain pods might become unplaced if you remove nodes.

Working with Optimize Container Cluster Plan Results

After the plan runs, you can view the results to see how the plan settings you configured affect your environment.

The screenshot shows the 'Optimize Container Cluster 1' interface. On the left, under 'CONFIGURATION', there are three sections: 'Container Spec Action Settings' (Scale for ContainerSpec: ENABLED), 'Container Pod Action Settings' (Move for Container Pods: ENABLED), and 'Virtual Machines Action Settings' (Provision for Virtual Machines: ENABLED, Suspend for Virtual Machines: ENABLED, Scale for Virtual Machines: ENABLED). On the right, under 'RESULTS OVERVIEW', is the 'Optimize Container Cluster Summary' table for 'Kubernetes-PT-AKS'.

	Current	After Plan	Difference	%
Container Pods	118	113	5	▼ 4.2 %
Virtual Machines	8	7	1	▼ 12.5 %
Pod Density	14.8 : 1	16.1 : 1	1.3 : 1	▲ 8.8 %
Cluster CPU Capacity	20 Cores	22 Cores	2 Cores	▲ 10 %
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Cluster Memory Overcommitment	83.7 %	45.4 %	38.3 %	▼ 45.8 %

At the bottom right of the table, there is a 'SHOW ALL' link with a right arrow.

General Guidelines

Familiarize yourself with these common terms that appear in many sections of the plan results:

- A container pod represents the compute demand from a running pod.

- A Kubernetes node (virtualized or bare metal) is represented as a VM.
- *Used* (or *Usage*) values represent actual resource consumption. For example, a node that consumes 100 MB of memory has a used value of 100 MB.
- *Utilization* values represent used/usage values against capacity. For example, a node that consumes 100 MB of memory against a total capacity of 500 MB has a utilization value of 20%.

Optimize Container Cluster Summary

RESULTS OVERVIEW

PLAN ACTIONS (258)

Optimize Container Cluster Summary

Kubernetes-PT-AKS

	Current	After Plan	Difference	%
Container Pods	118	113	5	▼ 4.2 %
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Cluster CPU Overcommitment	261 %	223.2 %	37.8 %	▼ 14.5 %
Cluster Memory Overcommitment	83.7 %	45.4 %	38.3 %	▼ 45.8 %

SHOW ALL >

This chart shows how your container environment and the underlying resources will change after you execute the actions that the plan recommends. The chart shows the following information:

- **Container Pods**

Count of active container pods in the plan.

- **Virtual Machines**

Count of active nodes in the plan. This chart does not count "non-participating" entities in the real-time market, such as suspended nodes.

- **Pod Density**

Average number of pods per node.

For the total number of pods against the node capacity (maximum pods per node), see the **Number of Consumers** data in the following charts:

- Nodes (VMs) Optimized Improvements
- Nodes (VMs) Comparison
- Container Cluster Optimized Improvements

– Container Cluster Comparison

- **Cluster CPU Capacity**

Total CPU capacity for the cluster. The 'After Plan' result indicates how much CPU capacity will result in the optimal number of nodes required to run workloads.

- **Cluster Memory Capacity**

Total memory capacity for the cluster. The 'After Plan' result indicates how much memory capacity will result in the optimal number of nodes required to run workloads.

- **Cluster Allocatable CPU**

Total amount of cluster CPU available for pod requests. The 'After Plan' result indicates how much of the allocatable CPU capacity will change if you provision or suspend nodes.

- **Cluster Allocatable Memory**

Total amount of cluster memory available for pod requests. The 'After Plan' result indicates how much of the allocatable memory capacity will change if you provision or suspend nodes.

- **Cluster CPU Overcommitment**

(Only for containers with CPU limits) This indicates whether the CPU limits exceed the capacity of the underlying nodes. A value greater than 100% indicates overcommitment. Turbonomic manages cluster resources by actual utilization and limit rightsizing so that you can run more workloads with less risk.

Turbonomic only calculates overcommitment in plans. The calculation can be expressed as:

```
Overcommitment = Sum of CPU limits for all containers / Sum of CPU capacity for all nodes
```

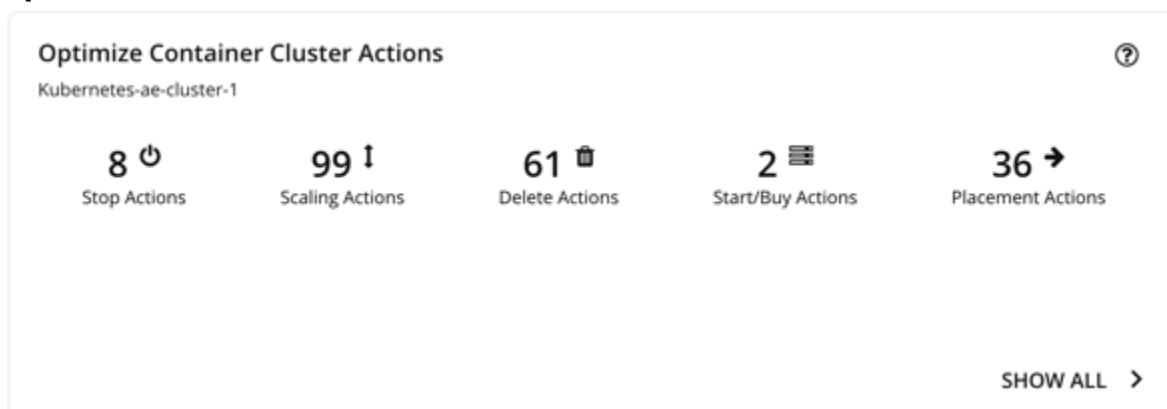
- **Cluster Memory Overcommitment**

(Only for containers with memory limits) This indicates whether the memory limits exceed the capacity of the underlying nodes. A value greater than 100% indicates overcommitment. Turbonomic manages cluster resources by actual utilization and limit rightsizing so that you can run more workloads with less risk.

Turbonomic only calculates overcommitment in plans. The calculation can be expressed as:

```
Overcommitment = Sum of memory limits for all containers / Sum of memory capacity for all nodes
```

Optimize Container Cluster Actions



This chart summarizes the actions that you need to execute to achieve the plan results. For example, you might need to resize limits and requests for containers (via the associated Workload Controllers) to address performance issues. Or, you might need to move pods from one node to another to reduce congestion.

Smarter redistribution and workload rightsizing also drive cluster optimization, resulting in the need to provision node(s) based on application demand, or to defragment node resources to enable node suspension.

Turbonomic can recommend the following actions:

- Resize namespace compute resource quotas
- Resize container limits and requests

Note:

Executing several container resize actions can be very disruptive since pods need to restart with each resize. For replicas of the container scale group(s) related to a single Workload Controller, Turbonomic consolidates resize actions into one *merged action* to minimize disruptions. When a merged action has been executed (via the associated Workload Controller), all resizes for all related container specifications will be changed at the same time, and pods will restart once.

- Move pods
- Provision or suspend nodes
- Scale volumes

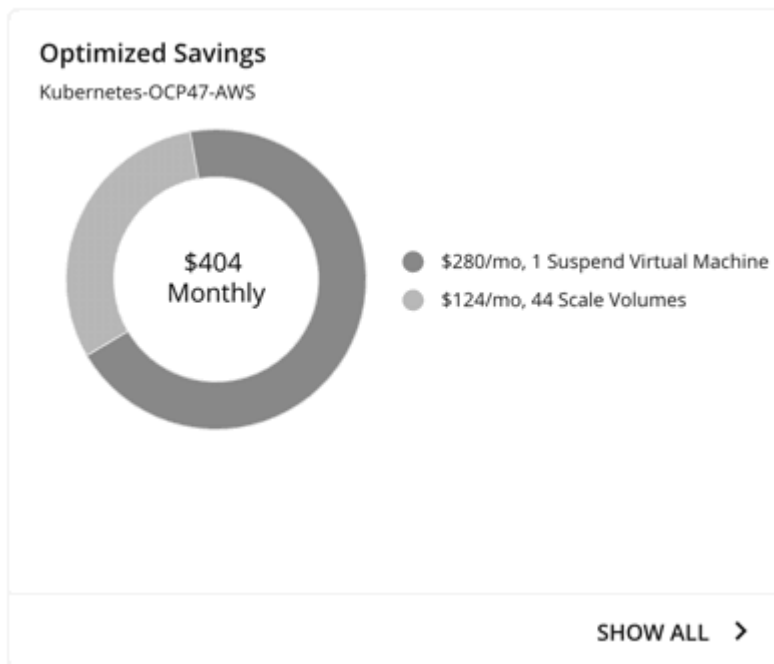
Note:

For a cluster in the public cloud, Turbonomic shows the cost impact of actions on nodes and volumes, to help you track your cloud spend. Turbonomic only reports the costs attached to these actions, and does *not* perform cost analysis on the cluster. See the Optimized Savings and Optimized Investments charts for more information.

For an on-prem cluster, Turbonomic can also recommend the following actions:

- Move VMs
- Provision or suspend hosts
- Provision or suspend storage

Optimized Savings



For a cluster in the public cloud, Turbonomic shows the savings you would realize if you execute the actions (such as node suspension) that the plan recommends to increase infrastructure efficiency. Note

that efficiency is the driver of this action, *not* cost. Cost information is included to help you track your cloud spend.

The chart shows total monthly savings. Click **Show All** to view the actions with cost savings.

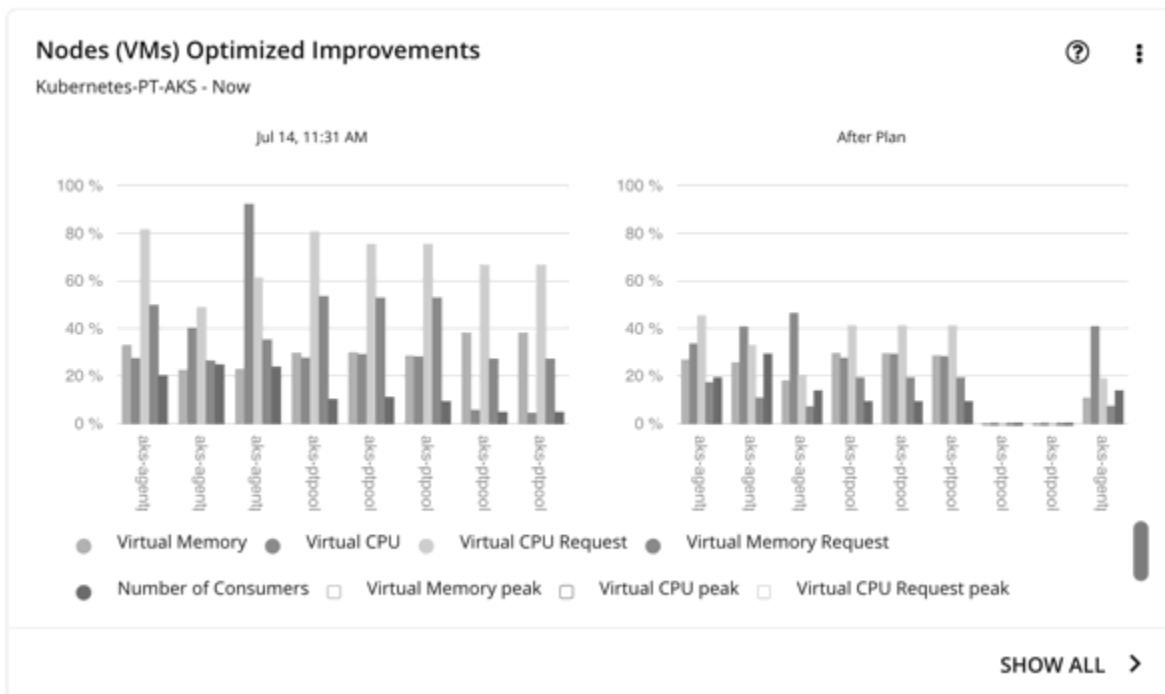
Optimized Investments



For a cluster in the public cloud, Turbonomic shows the costs you would incur if you execute the node and volume scaling actions that the plan recommends to address performance issues. For example, if some applications risk losing performance, Turbonomic can recommend provisioning nodes to increase capacity. This chart shows how these actions translate to an increase in expenditure. Note that performance and efficiency are the drivers of these actions, *not* cost. Cost information is included to help you plan for the increase in capacity.

The chart shows total monthly investments. Click **Show All** to view the actions that require investments.

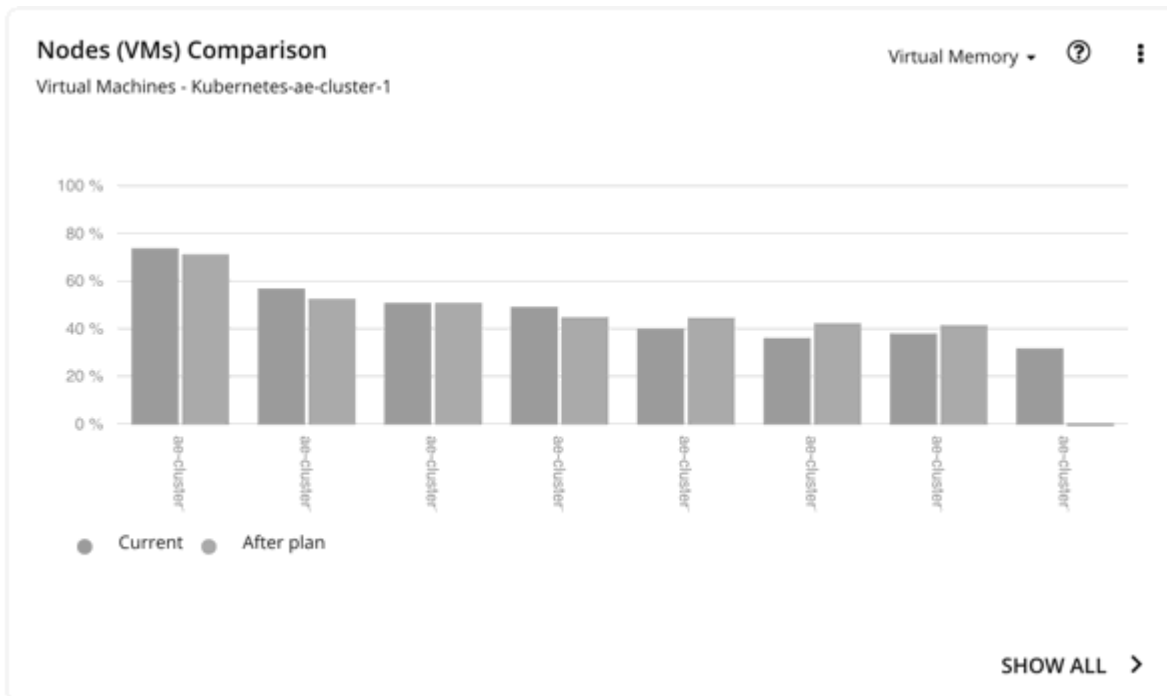
Nodes (VMs) Optimized Improvements



This chart compares the following before and after the plan:

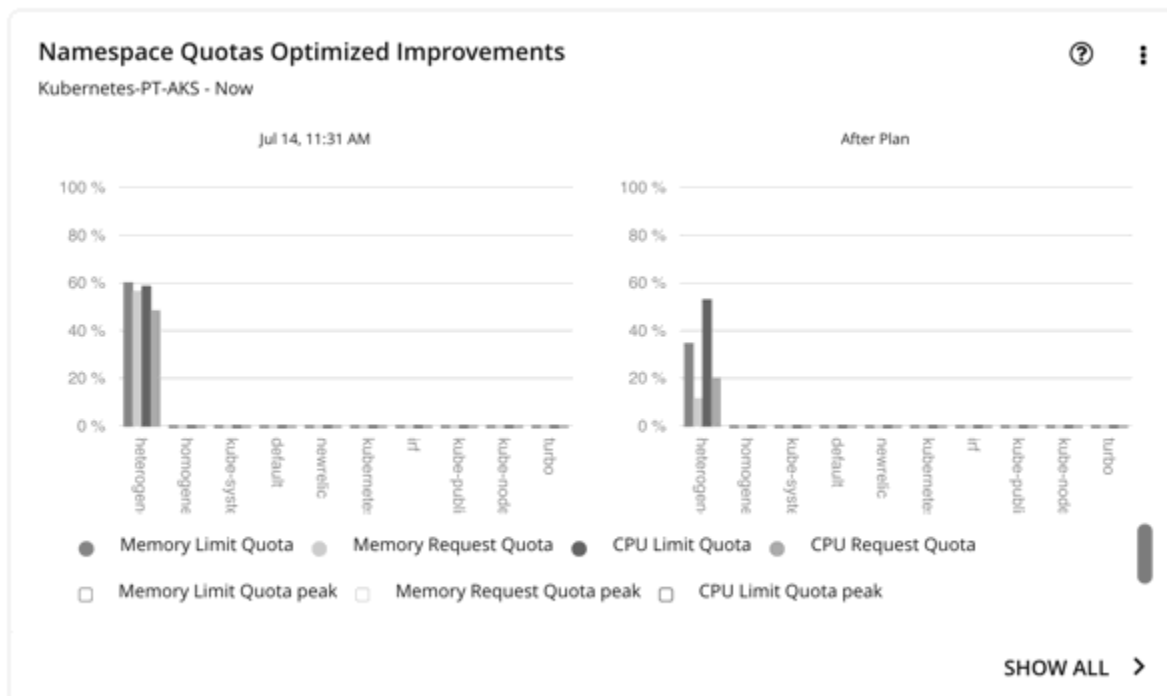
- Utilization of the following for all nodes:
 - vMem
 - vCPU
 - vMem Request
 - vCPU Request
- Number of pods consuming resources against the maximum pod capacity for all the nodes

Nodes (VMs) Comparison



This chart compares node resource utilization (one metric at a time) before and after the plan.

Namespace Quotas Optimized Improvements



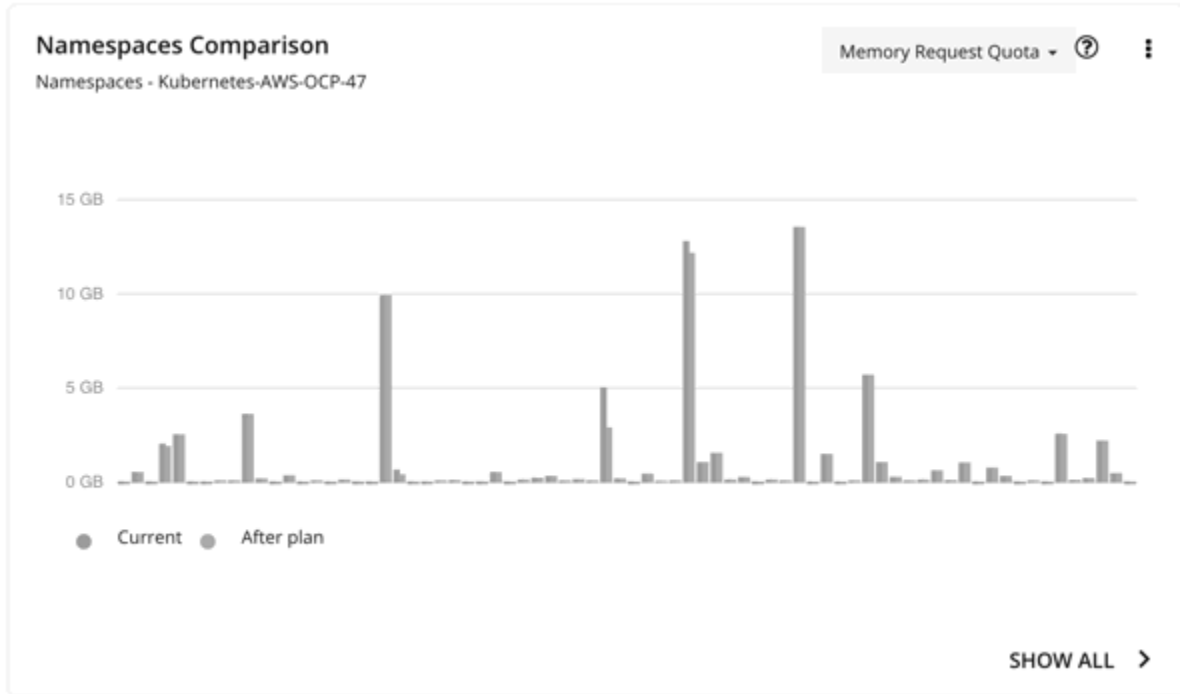
This chart shows pod utilization of resource quotas defined in namespaces. Resource quotas include:

- CPU Limit Quota
- Memory Limit Quota
- CPU Request Quota
- Memory Request Quota

For namespaces without defined quotas, utilization is 0 (zero).

With or without quotas, you can see the sum of pod limits and requests per namespace. Go to the top-right section of the Plan Results page, click the download button, and select **Namespace**. Utilization data in the downloaded file shows these limits and requests. You can also compare usage values in the Namespaces Comparison chart.

Namespaces Comparison



This chart compares namespace quota usage (one metric at a time) before and after the plan.

Use this chart to see how container resizing changes the limits and requests allocated per namespace, whether you leverage quotas or not.

To achieve the 'After Plan' results, click **Show All**. In the Details page that opens, go to the Name column and then click the namespace link. This opens another page with a list of pending actions for the namespace.

Namespaces Comparison

↓

	Current			After Plan		
Name	Memory Limit Quota Capacity	Memory Limit Quota Used	Memory Limit Quota Utilization	Memory Limit Quota Capacity	Memory Limit Quota Used	Memory Limit Quota Utilization
robotshop	25 GB	3.6 GB	14.6 %	25 GB	3.6 GB	14.6 %

Namespace @ robotshop

11

Service

13

Application Component

13

Container

13

Container Spec

OVERVIEW

DETAILS

POLICIES

ACTIONS (22)

Search...

☐

Resize VMem Limit,VCPU Limit for Workload Controller mysql

Underutilized VMem Limit, VCPU Limit Congestion in Container Spec mysql

PERFORMANCE

☐

Resize VMem Limit,VCPU Limit for Container Spec mysql

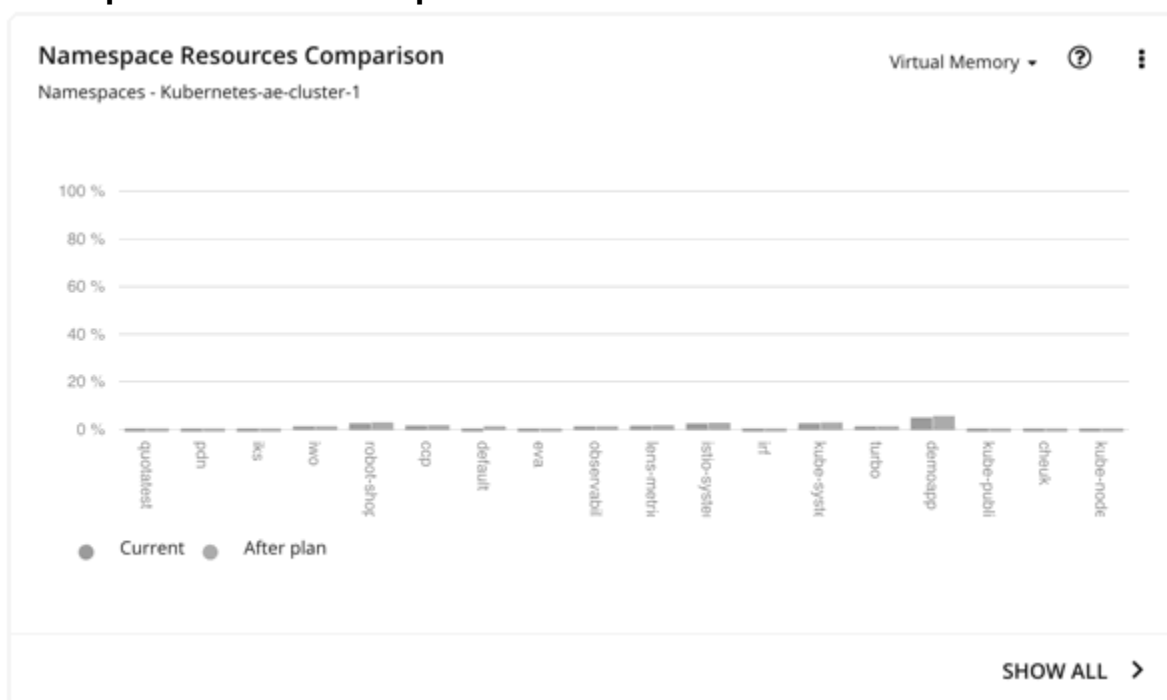
Underutilized VMem Limit, VCPU Limit Congestion in Container Spec mysql

PERFORMANCE

APPLY SELECTED

↓

Namespace Resources Comparison



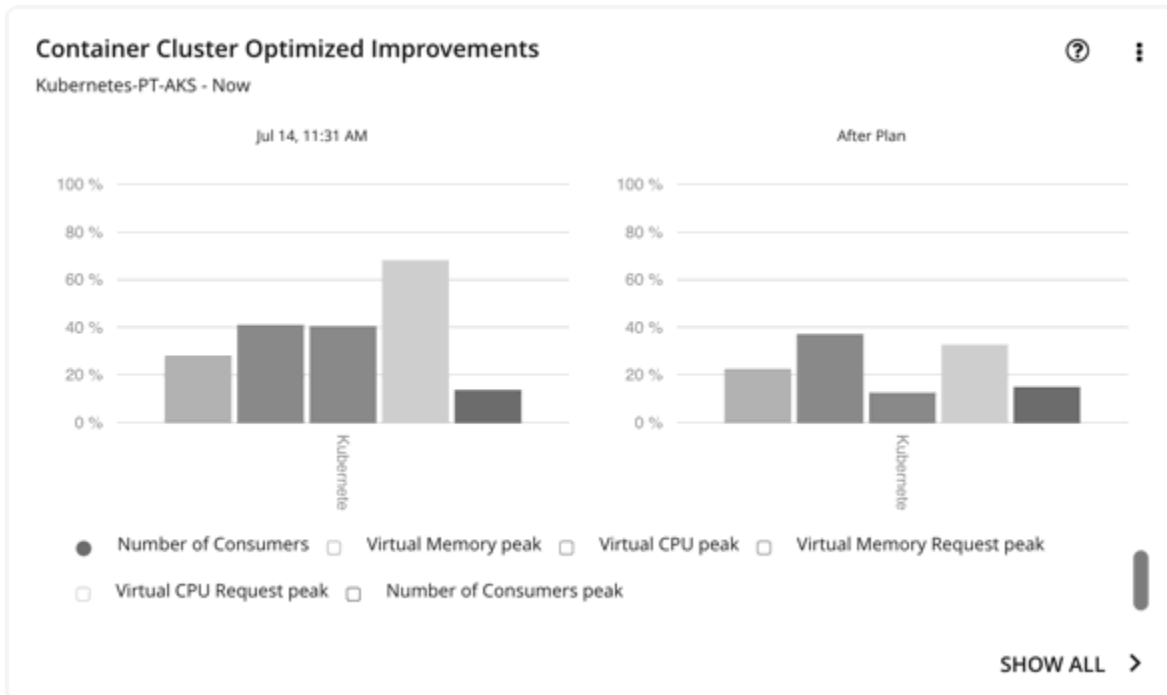
This chart shows how much cluster resources per namespace are utilized by pods. Utilization can be expressed as follows:

$$\text{Utilization} = \text{Sum of actual vMem/vCPU used by pods} / \text{vMem/vCPU capacity for the cluster}$$

This information helps you understand which namespaces use the most cluster resources. You can also use it for showback analysis. vMem and vCPU utilized by pods in the namespaces would change when the number of nodes changes as a result of executing the plan actions.

This chart is especially useful if you do not have resource quotas defined in your namespaces.

Container Cluster Optimized Improvements



This chart shows the following, assuming you execute all actions in the plan:

- Changes to the utilization of cluster resources
- Overcommitment values

Container Cluster Comparison



This chart compares the following before and after the plan:

- Utilization of cluster resources (one metric at a time)
- Overcommitment values

Optimized Improvements for Hosts, Storage, and Virtual Machines

Use these charts if you ran the plan on an on-prem Kubernetes cluster. These charts show how the utilization of resources would change assuming you accept all of the actions listed in the Plan Actions chart

Hosts, Storage Devices, and Virtual Machines Comparison

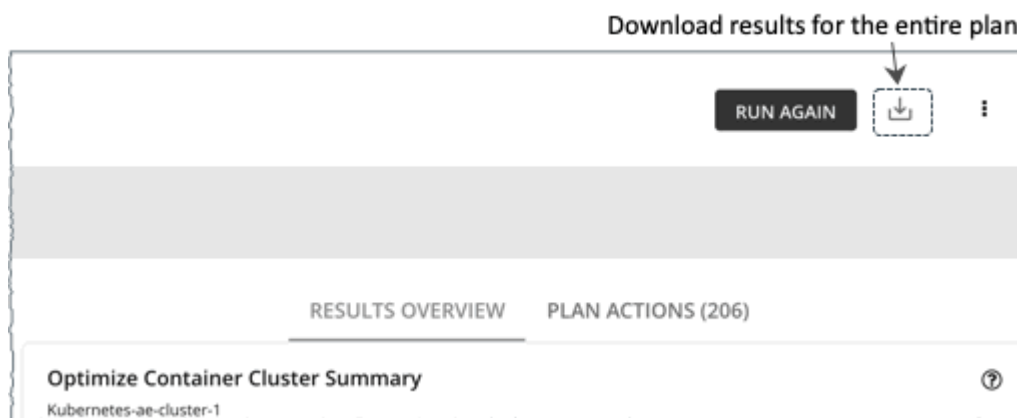
Use these charts if you ran the plan on an on-prem Kubernetes cluster. These charts show how the utilization of a particular commodity (such as memory or CPU) for each entity in the plan would change if you execute the recommended actions.

Note:

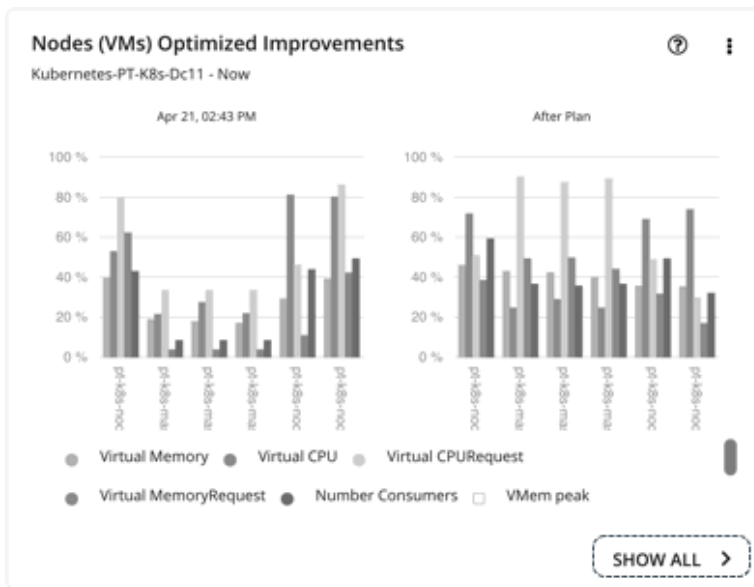
For the Storage Devices Comparison chart, if you set the view to **VM Per Storage** and click **Show all**, the total number of VMs sometimes does not match the number in the Summary chart. This happens if there are VMs in the plan that use multiple storage devices. The Storage Devices Comparison chart counts those VMs multiple times, depending on the number of storage devices they use, while the Plan Summary chart shows the actual number of VMs.

Downloading Plan Results

To download results for nodes, namespaces, or the container cluster, click the download button at the top-right section of the Plan Results page.



You can also download the plan results shown in individual charts. Click the **Show All** button for a chart, and then the download button at the top-right section of the Details page.



Nodes (VMs) Optimized Improvements ×

Download ← Download results shown in chart

Virtual Machine Name	Container Cluster	Number Consu...	Number Consu...	Virtual CPU	Virtual CPU	Virtual CPURE...	Virtual CPURE...
pt-k8s-node-2	Kubernetes-PT-K8...	49.1 %	49.1 %	80 %	82.1 %	86.1 %	86.1 %
pt-k8s-node-1	Kubernetes-PT-K8...	42.7 %	42.7 %	52.7 %	59.5 %	79.5 %	79.5 %

For charts that display infinite capacities (for example, the Namespaces Comparison chart), the downloaded file shows an unusually high value, such as 1,000,000,000 cores, instead of the ∞ symbol.

Re-Running the Plan

You can run the plan again with the same or a different set of configuration settings. This runs the plan scenario against the market in its current state, so the results you see might be different, even if you did not change the configuration settings.

Use the toolbar on top of the Configuration section to change the configuration settings.

Note:

It is not possible to change the scope of the plan in the Plan Page. You will need to start over if you want a different scope. To start over, go to the top-right section of the page, click the More options icon (⋮), and then select **New Plan**.

When you are ready to re-run the plan, click **Run Again** on the top-right section of the page.

Optimize Cloud Plan

Run the Optimize Cloud plan to see how you can maximize savings while still assuring performance for your applications and workloads. This plan identifies ways to optimize your costs by choosing the best templates (most adequate compute resources), regions, accounts, or resource groups to host your workloads. The plan also identifies workloads that can change over to RI pricing plans, and it compares your current costs to the costs you would get after executing the plan recommendations.

Optimize Cloud 56

SCOPE
Prod

RUN AGAIN

Actions
RI Profile

CONFIGURATION

RI Profile

Buy RIs
ENABLED

AWS: Offering Class
STANDARD

AWS: Term
1 YEAR

AWS: Payment
ALL UPFRONT

RI Inventory
23 OUT OF 23 ACT

Virtual Machine Action Settings

Scale for Virtual Machines
DISABLED

RESULTS OVERVIEW
PLAN ACTIONS (20)

Cloud Cost Comparison

	CURRENT	OPTIMIZED	DIFFERENCE	%
Workloads with performance risks	0 Out Of 125	0 Out Of 125	0	-
Workloads with efficiency opportunities	0 Out Of 125	0 Out Of 125	0	-
Workloads out of compliance	0 Out Of 125	0 Out Of 125	0	-
RI Coverage	21 %	92 %	▲ 338.1 %	
RI Utilization	49 %	16 %	▼ 67.3 %	
On-Demand Compute Cost	\$10,330 /mo	\$2,961 /mo	-\$7,369 /mo	▼ 71.3 %
Reserved Compute Cost	\$2,123 /mo	\$6,802 /mo	\$4,679 /mo	▲ 220.4 %
On-Demand Database Cost	\$1,634 /mo	\$1,634 /mo	\$0 /mo	0 %
Storage Cost	\$3,442 /mo	\$3,442 /mo	\$0 /mo	0 %
Total Cost	\$17,529 /mo	\$14,839 /mo	-\$2,690 /mo	▼ 15.3 %

Configuring an Optimize Cloud Plan

For an overview of setting up plan scenarios, see [Setting Up Plan Scenarios](#).

1. Scope

You can scope by:

Select Scope to Optimize

CLOUD

Accounts (7)

Billing Families (3)

Cloud Providers (2)

Resource Groups (35)

Regions (43)

☒ All Providers

☐ AWS

☐ Azure

- Accounts

Choose an AWS account or Azure subscription for the plan's scope. If you choose an Account for the scope, then the plan will not calculate RI Buy actions. To optimize RI purchases for a limited scope, choose a Billing Family.

- Billing Families

Include RI purchases in the planning for a scope that is limited to a single billing family. The plan calculates RI purchases through the billing family's master account.

- Cloud Providers

See how you can optimize all your AWS or Azure workloads.

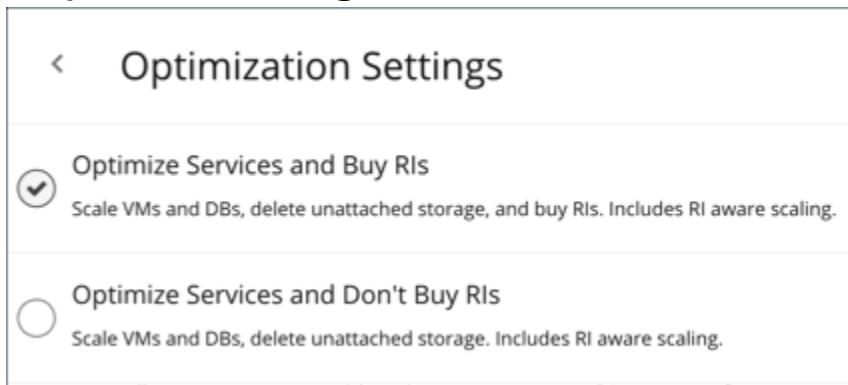
- Resource Groups

Turbonomic discovers Azure resource groups. You can select one or more resource groups for the plan scope.

- Regions

Focus the plan on a provider's region.

2. Optimization Settings



Choose from the given optimization options. Note that if you set a plan's scope to a resource group, Turbonomic will optimize services without recommending new RI purchases.

If your goal is to buy RIs for VMs at their current sizes, use the Buy VM Reservations plan type. For details, see [Buy VM Reservations Plan](#).

Note:

If you turn on the **Disable All Actions** setting in the global default policy and then run an Optimize Cloud plan with VM scaling and RI purchases enabled, the plan results show inaccurate RI recommendations.

Turn off **Disable All Actions** to resolve this issue. Be aware that after you turn off this setting, it will take Turbonomic a week to reflect accurate results in Optimize Cloud plans.

3. Reserved Instances Settings

For **Plan RI Inventory**, the RIs for the current scope are selected by default. Click **Edit** to make changes.

For **RI Purchase Profile**, the settings that you have set up for real-time analysis are selected by default. You can change the settings to see how they affect costs. For more information about RI Purchase, see [RI Purchase Profile](#).

- OFFERING CLASS

For AWS environments, choose the offering class that corresponds to the RI types that you typically use in your environment.

- TERM

For AWS and Azure environments, choose the payment terms you contract for your RIs. TERM can be one of **1 Year** or **3 Year**. Typically, longer term payment plans cost less per year.

- PAYMENT

The payment option that you prefer for your AWS RIs:

- All Upfront – You make full payment at the start of the RI term.
- Partial Upfront – You make a portion of the payment at the start of the term, with the remain cost paid at an hourly rate.
- No Upfront – You pay for the RIs at an hourly rate, for the duration of the term.

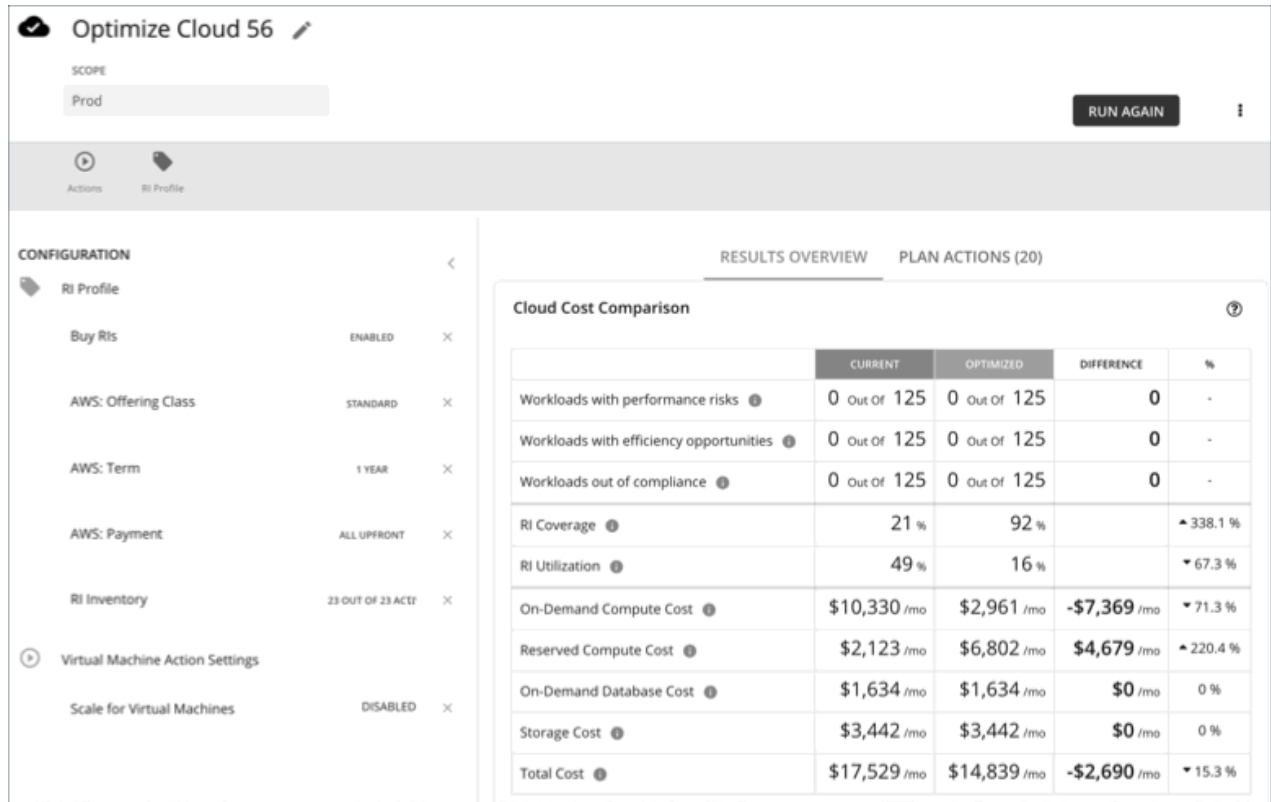
Working With Optimize Cloud Plan Results

After the Optimize Cloud plan runs, you can view the results to see how you can maximize savings or make other improvements to your cloud environment.

The plan results:

- Compare current to optimized costs, including on-demand compute, reserved compute, on-demand database, and storage costs
- Compare current and optimized breakdowns of templates used
- Compare breakdowns of storage tiers in use
- Project the RI coverage (how many workloads use RI) and utilization (percentage of RIs that are active)
- Identify candidates for Reserved Instance (RI) pricing, and show the cost benefits you can see by running those workloads on templates that are reserved on your public cloud provider.

Viewing the Results



The plan results include the following charts:

• Cloud Cost Comparison

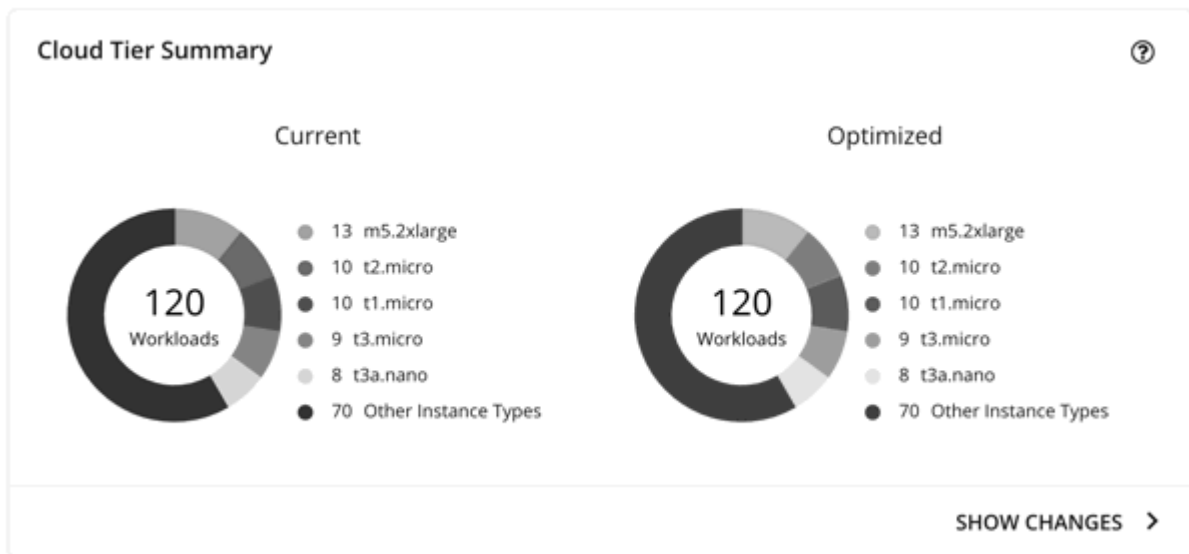
This chart highlights any difference in cost as a result of optimization. For example, undersized VMs risk losing performance and should therefore scale up. This could contribute to an increase in cost. On the other hand, oversized VMs can scale down to less expensive instances, so cost should go down. The values under the **%** column indicate the percentage of VMs that are affected by optimization cost calculations.

Turbonomic can also recommend that you purchase RI capacity to reduce costs. The analysis looks at workload history to identify RI candidates. This considers the count of workloads in a family, plus their hours of active-state condition, to arrive at the RI capacity you should purchase. Since RI costs are incurred at the account level, the Cloud Cost Comparison chart will present RI costs or charges when you scope to an account or group of accounts (including a billing family).

For AWS clouds, Turbonomic can get the information it needs to display license costs for database instances. For Azure clouds, Turbonomic does not display database license costs because Azure does not make that information available.

• Workload Mapping

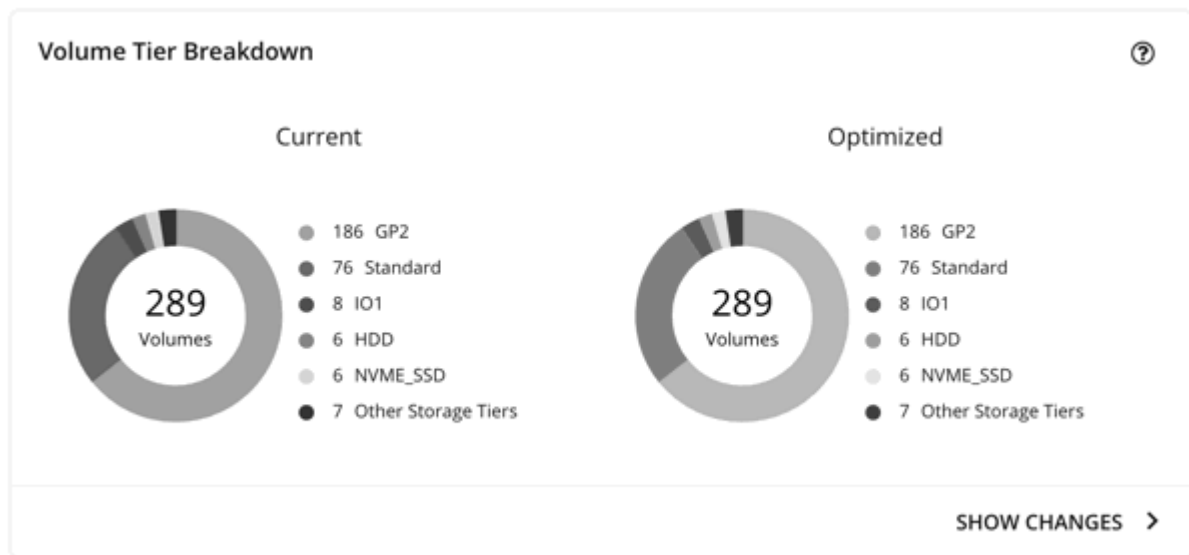
This chart shows the types of tiers you currently use, compared to the tiers the plan recommends, including how many of each type, plus the costs for each.



To see a detailed breakdown of the template costs, click **SHOW CHANGES** at the bottom of the chart.

- **Volume Tier Breakdown**

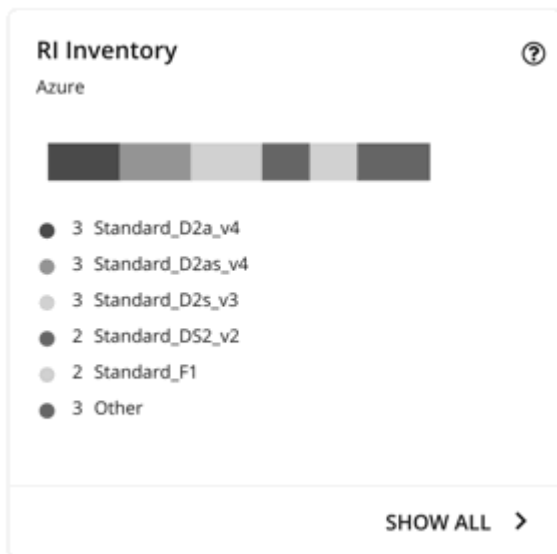
This chart shows the distribution of storage that supports your workloads in Current and Optimized graphs.



The difference in the result reflects the number of unattached volumes. To see a list of unattached volumes, click **Show changes** at the bottom of the chart.

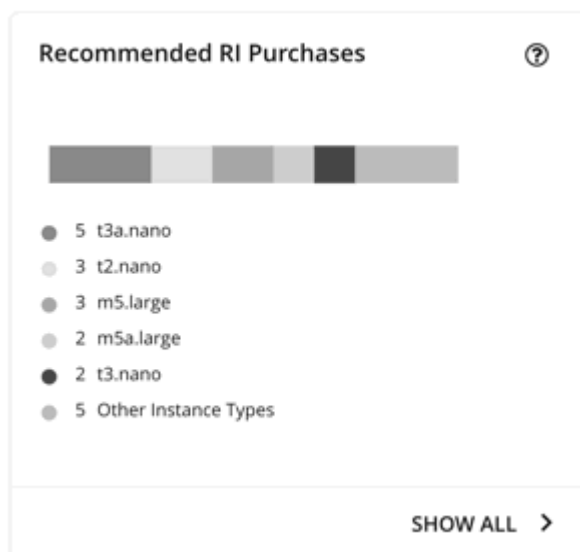
- **Plan RI Inventory**

This chart shows the RI workloads that Turbonomic discovers and lists them by tiers. For a tabular listing, click **Show All** at the bottom of the chart. In the tabular listing, you can see if an RI expired before the specified purchase date.



- **Recommended RI Purchases**

This chart shows the RIs the plan recommends to buy. To see the details, click **SHOW ALL** at the bottom of the chart.



Viewing Plan Actions

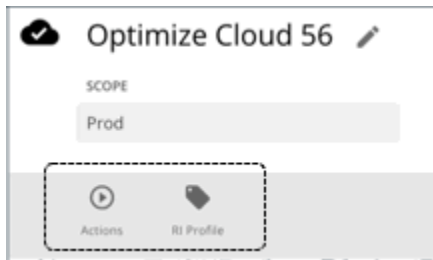
Click the **Plan Actions** tab on top of the page to view a list of actions that you need to execute to achieve the plan results.

RESULTS OVERVIEW		PLAN ACTIONS (20)	
<div> <div>Q</div> <div>Search...</div> </div>		<div> <div> <div></div> <div>FILTER</div> </div> <div> <div></div> <div>Download</div> </div> </div>	
<div> <div>Buy 1 t3.nano RIs for [redacted] in aws-US East (Ohio)</div> <div>Increase RI Coverage by 79%</div> </div>		EST. SAVINGS: \$0.404/mo	<div>EFFICIENCY</div> <div>></div>
<div> <div>Buy 2 t3a.nano RIs for [redacted] in aws-US East (Ohio)</div> <div>Increase RI Coverage by 85%</div> </div>		EST. SAVINGS: \$2.03/mo	<div>EFFICIENCY</div> <div>></div>
<div> <div>Buy 1 t3a.nano RIs for [redacted] in aws-US Eas...ia)</div> <div>Increase RI Coverage by 99%</div> </div>		EST. SAVINGS: \$1.37/mo	<div>EFFICIENCY</div> <div>></div>

Re-Running the Plan

You can run the plan again with the same or a different set of configuration settings. This runs the plan scenario against the market in its current state, so the results you see might be different, even if you did not change the configuration settings.

Use the toolbar on top of the Configuration section to change the configuration settings.



- Actions

Use this to enable or disable automatic Scale actions for the virtual machines in the plan.

- RI Profile

Change RI Purchase Profile settings that match the cloud settings you have set up for real-time analysis. For details, see [Reserved Instance Settings](#).

Note:

It is not possible to change the scope of the plan in the Plan Page. You will need to start over if you want a different scope. To start over, go to the top-right section of the page, click the More options icon (⋮), and then select **New Plan**.

When you are ready to re-run the plan, click **Run Again** on the top-right section of the page.

Migrate to Cloud Plan

The screenshot displays the 'Migrate to Public Cloud 85' interface. At the top, it shows 'WHAT TO MIGRATE' as 'HawthorneHC, DC24-Data...' and 'WHERE TO MIGRATE' as 'aws-US West (N. California)'. A 'RUN AGAIN' button is visible. Below this is a 'CONFIGURATION' section with '1 Licensing' and 'Include OS cost'. The 'RI Profile' section shows 'AWS: Offering Class' as 'STANDARD', 'AWS: Payment' as 'ALL UPFRONT', 'AWS: Term' as '1 YEAR', and 'RI Inventory' as '0 OUT OF 0 ACTIVE'. To the right, a 'RESULTS OVERVIEW' section shows 'Unplaced Virtual Machines: Lift&Shift: 69; Optimized: 66'. Below this is a 'CLOUD COST COMPARISON' table for 'aws-US West (N. California)'.

	LIFT & SHIFT	OPTIMIZED	DIFFERENCE	%
Virtual Machines with performance risks	99 Out Of 684	0 Out Of 687	99	-
Virtual Machines with efficiency opportunities	588 Out Of 684	0 Out Of 687	588	-
On-Demand Compute Cost	\$113,460 /mo	\$23,214 /mo	-\$90,246	▼ 79.5 %
Reserved Compute Cost	\$9,816 /mo	\$19,229 /mo	\$9,413	▲ 95.9 %
Storage Cost	\$32,183 /mo	\$40,397 /mo	\$8,214	▲ 25.5 %
Total Cost	\$155,459 /mo	\$82,840 /mo	-\$72,619	▼ 46.7 %

A Migrate to Cloud plan simulates migration of on-prem VMs to the cloud, or migration of VMs from one cloud provider to another. This plan focuses on optimizing performance and costs by choosing the most suitable cloud resources for your VMs and the volumes they use. If analysis discovers VMs that are good candidates for Reserved Instances (RIs), then it recommends migrating to those instances, and can even recommend purchasing more RI capacity.

The plan calculates costs according to the billing and price adjustments that you have negotiated with your cloud provider. Costs include compute, service (such as IP services), and license costs. The plan also calculates RI purchases for VMs that can benefit from such pricing.

Note:

If your instance of Turbonomic is inoperative for a period of time, that can affect the cost calculations. To calculate costs for a VM that it will migrate to the cloud, Turbonomic considers the VM's history. For example, if the VM has been stable for 16 of the last 21 days, then Turbonomic will plan for that VM to use an RI. In this way, the plan calculates the best cost for the migration. However, if Turbonomic is inoperative for any time, that can impact the historical data such that the plan will *not* recognize a VM as stable, even though it is.

Points to consider:

- AWS includes EC2 Spot Instances that offer steep discounts. A plan that migrates from AWS to Azure will not migrate VMs that run on Spot Instances.
- Do not use this plan type to migrate within the same cloud provider (for example, moving VMs from one Azure subscription to another) as a way to test the effect on pricing. The results from such a plan would not be reliable.
- For migrations within your on-prem environment, use the *Virtual Machine Migration* plan type.
- Before migrating, consider turning on a setting in the default global policy that enables metrics collection for on-prem volumes attached to VMs. This allows Turbonomic to make more accurate placement decisions for the VMs and volumes you are migrating. For details, see [Enable Analysis of On-prem Volumes](#).

The plan results show:

- Projected costs
- Actions to execute your migration and optimize costs and performance

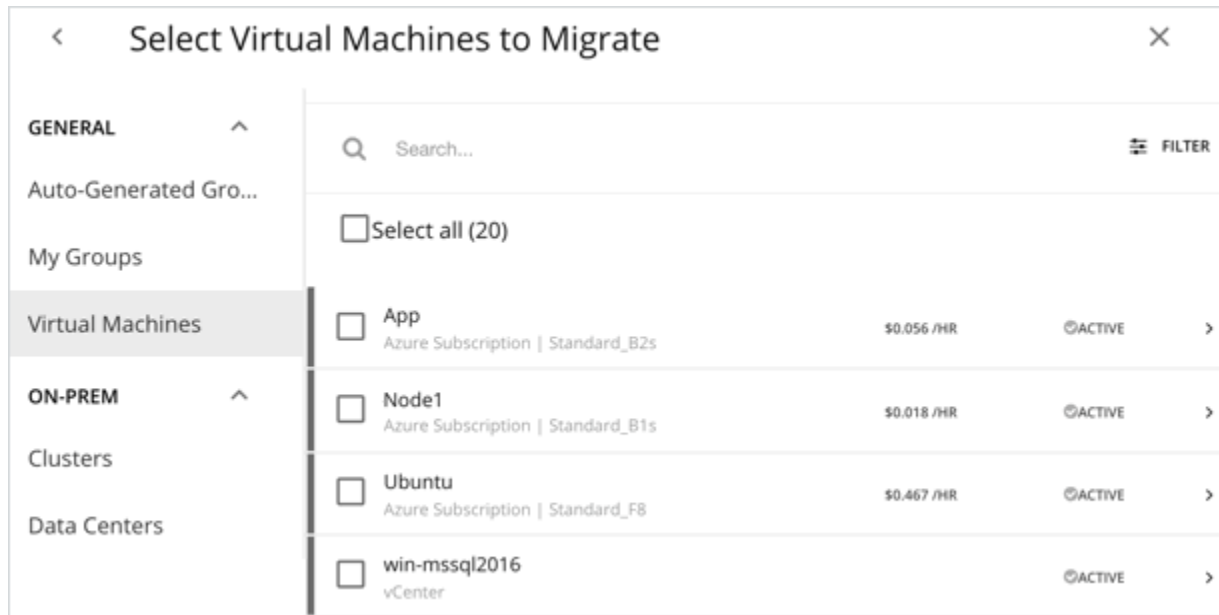
- Optimal cloud instances to use, combining efficient purchase of resources with assured application performance
- VMs that are good candidates for Reserved Instance (RI) pricing, and the cost benefits you would realize by running those VMs as RI instances
- RIs you should purchase (if you need more RI capacity)

Configuring a Migrate to Cloud Plan

For an overview of setting up plan scenarios, see [Setting Up Plan Scenarios](#).

1. Scope

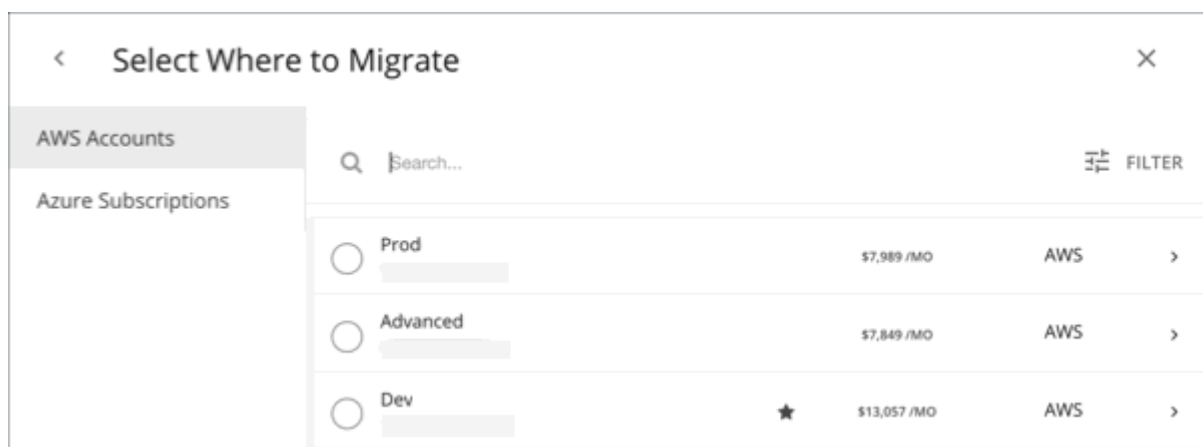
Select the VMs that you want to migrate. You can select VM groups and/or individual VMs.



If you select an Auto Scaling Group, Turbonomic simulates migrating the VMs individually, and not as a group.

2. Where to Migrate

Choose a billing account (AWS account or Azure subscription).



Choose a region. Turbonomic shows all the regions that you can access from your target cloud accounts.

Where to migrate

CLOUD ^

Regions

Search...

FILTER

Region	VMs	Status
aws-US West (N. California) AWS	1	ACTIVE
azure-West US 2 Azure Subscription	2	ACTIVE
azure-Australia East Azure Subscription	1	ACTIVE

By default, Turbonomic considers all instance types in the selected region when making placement decisions for the scoped VMs and the volumes they use. However, you may have set up constraints in policies that limit migration to certain instance types. If there are VMs and volumes in your scope that are affected by those policies, Turbonomic will only consider the instance types defined in the policies.

3. Licensing (OS Migration Profile)

Select an OS Profile for this migration.

Licensing

☐ Include OS cost
The plan includes OS cost per VM as part of the migration.

☐ BYOL ("Bring your own license")
The plan does not include OS cost as part of the migration. Use this option if you have purchased Azure Hybrid Benefit.

☒ Custom OS
The plan includes OS cost based on your selections.

SOURCE OS	TARGET OS	BYOL
Linux	Linux	<input checked="" type="checkbox"/>
RHEL	RHEL	<input checked="" type="checkbox"/>
SLES	SLES	<input checked="" type="checkbox"/>
Windows	Windows	<input checked="" type="checkbox"/>

On the cloud, instances usually include an OS platform to run processes on the VM. As you migrate VMs to the cloud, you can specify the OS you prefer to run. You can keep the same OS that the original VM has, or map it to a different OS.

- Include OS cost

As Turbonomic calculates placement for the migrated workloads, it will include costs for instances that provide the same OS that the VM already has.

- BYOL (Bring your own license)

This is the same as the **Include OS cost** option, except the plan does not include OS licensing costs in any of the cost calculations for on-cloud placement.

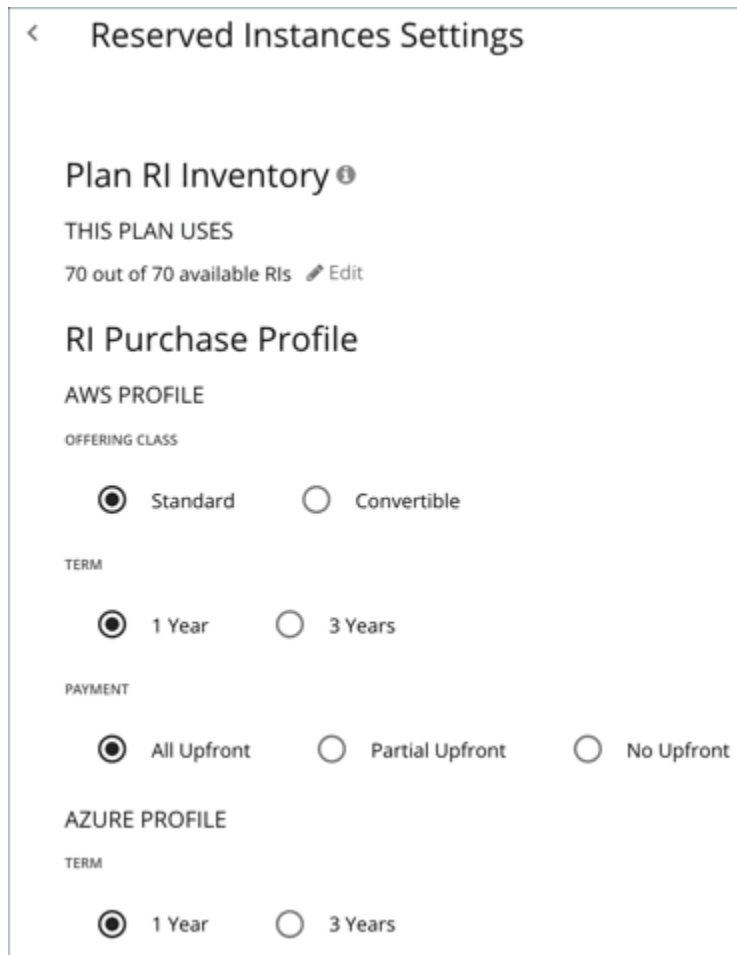
- Custom OS

For each of the listed OS types, map the migrated VM to the OS you choose. The OS types are:

- Linux – Any open source distribution of Linux. For the migration, Turbonomic will choose instances that provide the Linux platform that the cloud service provider delivers as a free platform. Note that this is always BYOL, because it assumes a free OS license.
- RHEL (Red Hat Enterprise Linux)
- SLES (SUSE Linux Enterprise Server)
- Windows

If you enable **BYOL** for RHEL, SLES, or Windows, Turbonomic assumes that you are paying for the OS license, and will not include the license cost in the plan results. If you do not enable **BYOL**, Turbonomic gets the license cost from the service provider and includes that cost in the plan results.

4. Reserved Instances Settings



< Reserved Instances Settings

Plan RI Inventory ⓘ

THIS PLAN USES
70 out of 70 available RIs [Edit](#)

RI Purchase Profile

AWS PROFILE

OFFERING CLASS

☒ Standard ☐ Convertible

TERM

☒ 1 Year ☐ 3 Years

PAYMENT

☒ All Upfront ☐ Partial Upfront ☐ No Upfront

AZURE PROFILE

TERM

☒ 1 Year ☐ 3 Years

For **Plan RI Inventory**, the RIs for the current scope are selected by default. Click **Edit** to make changes.

For **RI Purchase Profile**, the settings that you have set up for real-time analysis are selected by default. You can change the settings to see how they affect costs. For more information about RI Purchase, see [RI Purchase Profile](#).

- OFFERING CLASS

For AWS environments, choose the offering class that corresponds to the RI types that you typically use in your environment.

- **TERM**

For AWS and Azure environments, choose the payment terms you contract for your RIs. TERM can be one of **1 Year** or **3 Year**. Typically, longer term payment plans cost less per year.

- **PAYMENT**

The payment option that you prefer for your AWS RIs:

- All Upfront – You make full payment at the start of the RI term.
- Partial Upfront – You make a portion of the payment at the start of the term, with the remain cost paid at an hourly rate.
- No Upfront – You pay for the RIs at an hourly rate, for the duration of the term.

Working With Migrate to Cloud Plan Results

The Migrate to Cloud plan results show the cloud resources and costs for the VMs you plan to migrate, and the actions required for migration.

The screenshot displays the 'Migrate to Public Cloud' interface. At the top, it shows 'WHAT TO MIGRATE' as 'HawthorneHC, DC24-Data...' and 'WHERE TO MIGRATE' as 'aws-US West (N. California)'. A 'RUN AGAIN' button is visible. Below this is a 'CONFIGURATION' section with tabs for '1 Licensing' and 'RI Profile'. The 'RI Profile' tab is active, showing 'AWS: Offering Class' as 'STANDARD', 'AWS: Payment' as 'ALL UPFRONT', 'AWS: Term' as '1 YEAR', and 'RI Inventory' as '0 OUT OF 0 ACTIVE'. To the right, a 'RESULTS OVERVIEW' section shows 'Unplaced Virtual Machines: Lift&Shift: 69; Optimized: 66'. Below this is a 'CLOUD COST COMPARISON' table for 'aws-US West (N. California)'.

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Storage Cost	\$32,183 /mo	\$40,397 /mo	\$8,214 /mo	▲ 25.5 %
Total Cost	\$155,459 /mo	\$82,840 /mo	-\$72,619 /mo	▼ 46.7 %

Turbonomic shows results for two migration scenarios:

- **Lift & Shift**

Lift & Shift migrates your VMs to cloud instances that match their current resource allocations.

- **Optimized**

As Turbonomic runs the plan, it looks for opportunities to optimize cost and performance. For example, it might discover overprovisioned VMs after analyzing the historical utilization of VM resources. If you were to migrate such VMs to instances that match their current allocations, then you would spend more than necessary. For an optimized migration, Turbonomic can recommend migrating to less expensive instances while still assuring performance, and then show the resulting savings. In addition, when you examine the actions for an optimized migration, you will see charts that plot the historical utilization data used in the analysis.

Results Overview

The Results Overview section shows the following:

- **Unplaced VMs**

If the plan's scope includes VMs that cannot be migrated, the results include a notification indicating the number of VMs. Click **Show Details** to see the list of VMs and the reasons for their non-placement.

Unplaced Virtual Machines: Lift&Shift: 69; Optimized: 66
SHOW DETAILS

RESULTS OVERVIEW
LIFT & SHIFT ACTIONS (1437)
OPTIMIZED ACTIONS (1725)

CLOUD COST COMPARISON
aws-US West (N. California)

The charts in the plan results do not count these VMs.

Turbonomic displays adjusted CPU values for unplaced VMs. These values are the actual metrics used in analysis and are calculated using benchmark data. CPU values shown in other places (such as the Capacity and Usage chart) are unadjusted values obtained from targets.

- **Cloud Cost Comparison Chart**

This chart highlights any difference in cost as a result of optimization. For example, undersized VMs risk losing performance and should therefore scale up. This could contribute to an increase in cost. On the other hand, oversized VMs can scale down to less expensive instances, so cost should go down. The values under the **%** column indicate the percentage of VMs that are affected by optimization cost calculations.

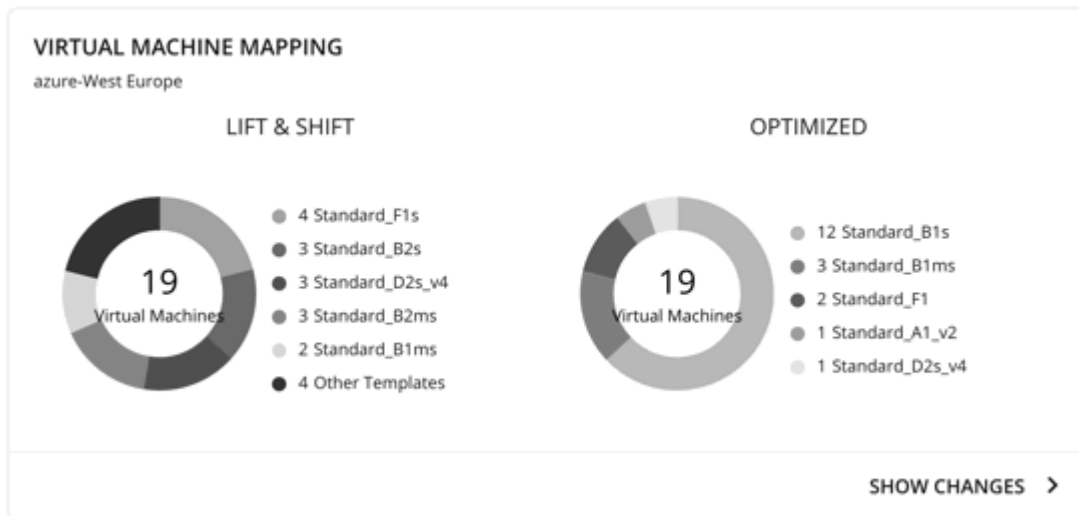
CLOUD COST COMPARISON				
aws-US West (N. California)				
	LIFT & SHIFT ⓘ	OPTIMIZED ⓘ	DIFFERENCE	%
Virtual Machines with performance risks ⓘ	99 Out Of 684	0 Out Of 687	99	-
Virtual Machines with efficiency opportunities ⓘ	588 Out Of 684	0 Out Of 687	588	-
On-Demand Compute Cost ⓘ	\$113,460 /mo	\$23,214 /mo	-\$90,246 /mo	▼ 79.5 %
Reserved Compute Cost ⓘ	\$9,816 /mo	\$19,229 /mo	\$9,413 /mo	▲ 95.9 %
Storage Cost ⓘ	\$32,183 /mo	\$40,397 /mo	\$8,214 /mo	▲ 25.5 %
Total Cost ⓘ	\$155,459 /mo	\$82,840 /mo	-\$72,619 /mo	▼ 46.7 %

Note:

For Azure, the results do not include the license cost for the migrated VMs.

- **Virtual Machine Mapping Chart**

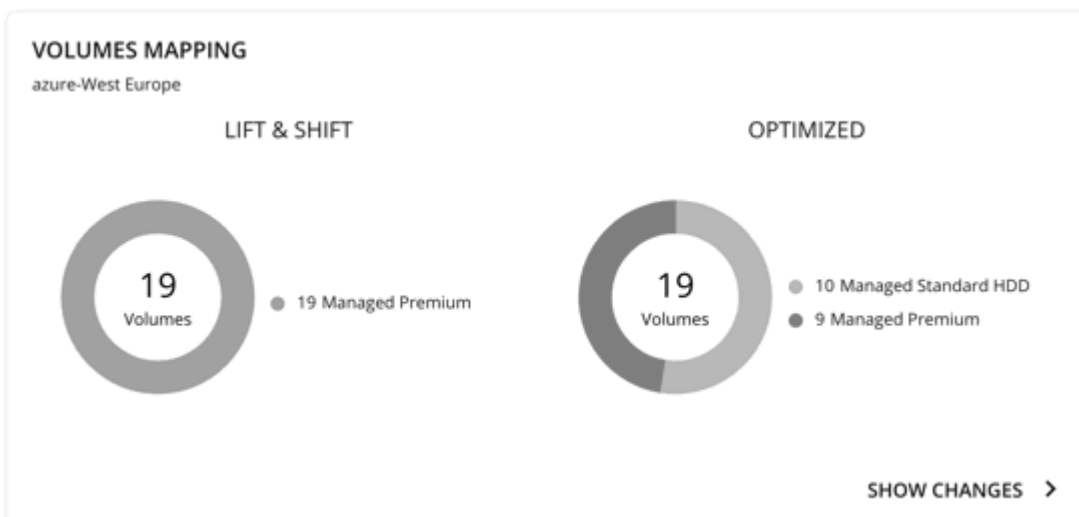
This chart gives a breakdown of the instance types that the plan recommends for the migration, including how many of each is needed.



Click **Show Changes** to see a table with details for each VM in the plan. The table maps VMs to instance types. It also shows the properties and monthly cost for each instance type, and indicates whether Turbonomic recommends buying an RI. Under the **Actions** column, click **Details** to compare Lift & Shift and Optimized actions.

- **Volume Mapping Chart**

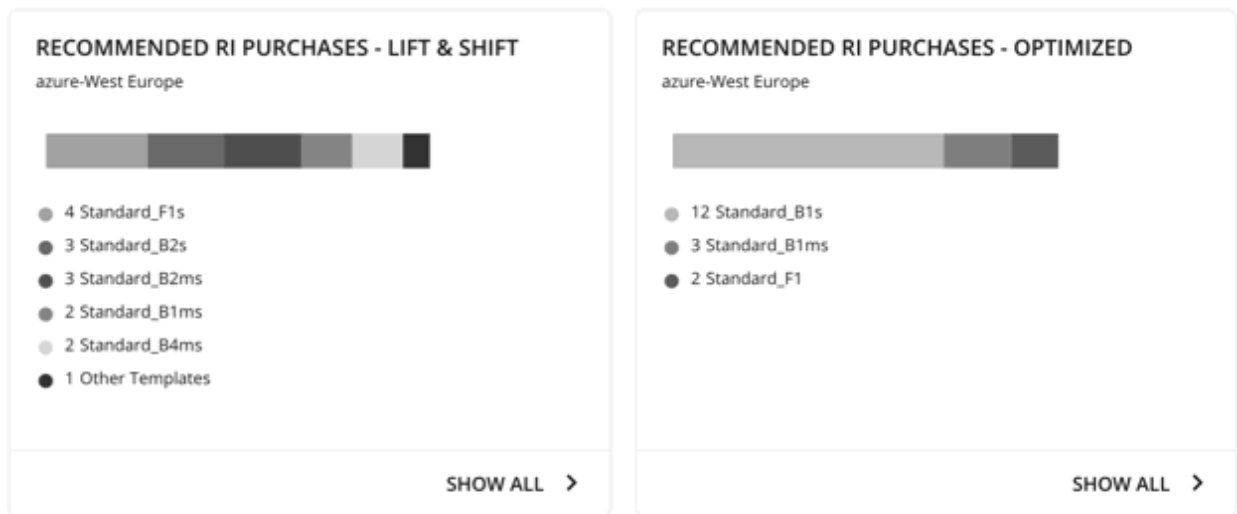
This chart gives a breakdown of the volume types that the plan recommends for the migration, including how many of each is needed.



Click **Show Changes** to see a table with details for each volume in the plan. The table maps the volumes you plan to migrate to the volume types that Turbonomic recommends. It also shows the properties and monthly cost for each volume type. Under the **Actions** column, click **Details** to compare Lift & Shift and Optimized actions.

- **Recommended RI Purchases Charts**

These charts list the RIs the plan recommends for the migration, including how many of each is needed.



To identify RI candidates, Turbonomic considers the history of a VM (by default, the last 21 days), and it looks for:

- Activity

If the VM's VCPU utilization percentile is 20% or higher, then Turbonomic considers it an active VM.

- Stability

If there have been no start, stop, or resize actions for the VM for 16 of the last 21 days, then Turbonomic considers it stable.

- RI Inventory (AWS only)

For AWS environments, Turbonomic compares the RI candidates to your current inventory of RI resources, plus your desired RI coverage. If the inventory can support the VM, then Turbonomic considers it an AWS RI candidate. If the inventory cannot support the VM, or if supporting it would exceed your desired RI coverage, then Turbonomic can recommend purchasing more RI capacity.

Note:

The plan assumes that an RI will always be less expensive than its on-demand counterpart. However, this is not always the case. There might be billing details from service providers that could lead to recommendations to migrate to an RI that is more expensive than running on demand.

Click **Show All** to see a table with details for each RI. The table shows the properties, up-front cost, and break-even period for each RI investment. It also indicates the monthly savings you would realize when you buy a specific RI. Under the **Actions** column, click **Details** to compare Lift & Shift and Optimized actions.

Plan Actions

Turbonomic shows separate tabs for **Lift & Shift** and **Optimized** migration actions. You can download the list of actions as a CSV file.

RESULTS OVERVIEW			LIFT & SHIFT ACTIONS	OPTIMIZED ACTIONS
<div> <div>Q</div> <div>Search...</div> </div> <div> <div>≡</div> <div>FILTER</div> </div>			<div> <div>↓</div> </div>	
Move Virtual Machine Latest 6.4.x from hp-dl563.e...com to aws-...ia)			EST. INVESTMENT: \$184/mo	
Lift & Shift migration			>	
Move Virtual Volume Vol-Latest 6...s03 from NIM...s03 to aws-U...ia)			EST. INVESTMENT: \$60/mo	
Lift & Shift migration			>	
Move Virtual Machine turbonomic....82 from hp-...com to aws-US ...ia)			EST. INVESTMENT: \$184/mo	
Lift & Shift migration			>	
Move Virtual Volume Vol...s02 from NIMHF40:Operations...s02 to ...			EST. INVESTMENT: \$119/mo	
Lift & Shift migration			>	

For *Optimized* migrations, when you expand an action on a VM, you will see charts that track VCPU and VMem utilization for that VM. With these charts, you can easily recognize the utilization trends that Turbonomic analyzed to determine the most efficient instance for the VM.



For more information about these charts, see [VCPU and VMem Utilization Charts for VMs](#).

Uploading Plan Results to Azure Migrate

Turbonomic can upload the plan results and additional plan information to the Azure Migrate portal as part of your migration process. This feature is only available for plans that simulate on-prem VM migration to an Azure region.

Uploaded information includes:

- Basic information for the on-prem VMs, including OS Name and Machine Name
- Target Azure region, VM size, and storage type

Note:

Azure Migrate does not support automatic selection of OS Disk or manual selection of Ultra Storage disk tiers as part of a migration plan.

- RI recommendations
- OS license recommendations (based on the licensing option that you selected for the plan)

Note:

The Azure Migrate portal displays standardized information provided by third-party migration assessment solutions, including Turbonomic. Microsoft might not support displaying some information unique to Turbonomic.

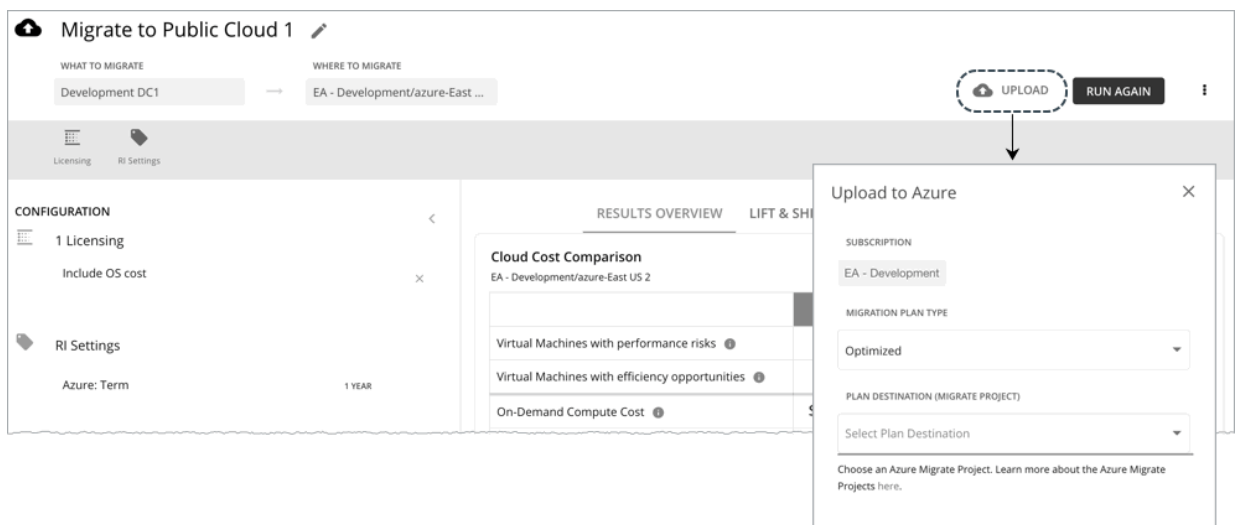
Before uploading the results, be sure to complete the following tasks:

1. Create a project in the Azure Migrate portal.
2. Add Turbonomic as a migration assessment solution to the project.
3. Set the necessary permissions in the Azure Migrate portal. Open Resource Explorer and configure the following operations:
 - Microsoft.Migrate/migrateprojects/read
 - Microsoft.Migrate/migrateprojects/solutions/read
 - Microsoft.Migrate/migrateprojects/solutions/getconfig/action

Consult the Azure documentation for information on completing these tasks.

When you are ready to upload:

1. Click **Upload** at the top-right corner of the Plan Page.



2. Specify the following:

- Migration Plan Type
Choose to migrate either the 'Lift & Shift' or 'Optimized' results.
- Plan Destination (Migrate Project)

Select from the list of Azure Migrate projects. These are the projects belonging to the Azure subscription that you selected for the plan. If you have not created a project for the subscription, go to the Azure Migrate portal and create one.

**Warning:**

Uploading to a project with existing plan results overwrites those results.

The upload will fail if another upload targeted at the same destination is already in progress.

3. Click **Submit**.

The Plan Page updates to display the upload status. Refresh the page periodically to check:

- If the upload task completed without problems
- Any upload issues for individual entities

4. When the upload is complete, log in to the Azure Migrate portal and go to the project you selected as the plan destination.

The project should now display the uploaded information. Use the migration tools identified for the project to start the actual migration.

Note:

Repeat the upload procedure if you re-ran the plan and want to upload the new results.

Re-Running the Plan

You can run the plan again with the same or a different set of configuration settings. This runs the plan scenario against the market in its current state, so the results you see might be different, even if you did not change the configuration settings.

Use the toolbar on top of the Configuration section to change the configuration settings.

Note:

It is not possible to change the scope of the plan in the Plan Page. You will need to start over if you want a different scope. To start over, go to the top-right section of the page, click the More options icon (⋮), and then select **New Plan**.

When you are ready to re-run the plan, click **Run Again** on the top-right section of the page.

Buy VM Reservations Plan

Buy VM Ris 4

SCOPE
Azure

RI Settings

CONFIGURATION

RI Settings

Azure: Term 1 YEAR

Virtual Machine Usage History 7 DAYS

Include Usage Data from Deleted VMs ENABLED

RI Inventory 16 OUT OF 16 ACT

RESULTS OVERVIEW **PLAN ACTIONS (151)**

Cloud Cost Comparison

Azure

	CURRENT	AFTER ACTIONS	DIFFERENCE	%
RI Coverage	6 %	94 %		▲ 1466.7 %
RI Utilization	81 %	98 %		▲ 21 %
On-Demand Compute Cost	\$7,331.00 /mo	\$1,233.00 /mo	-\$6,098.00 /mo	▼ 83.2 %
Reserved Compute Cost	\$821.00 /mo	\$4,296.00 /mo	\$3,475.00 /mo	▲ 423.3 %
Total Cost 	\$8,152.00 /mo	\$5,529.00 /mo	-\$2,623.00 /mo	▼ 32.2 %

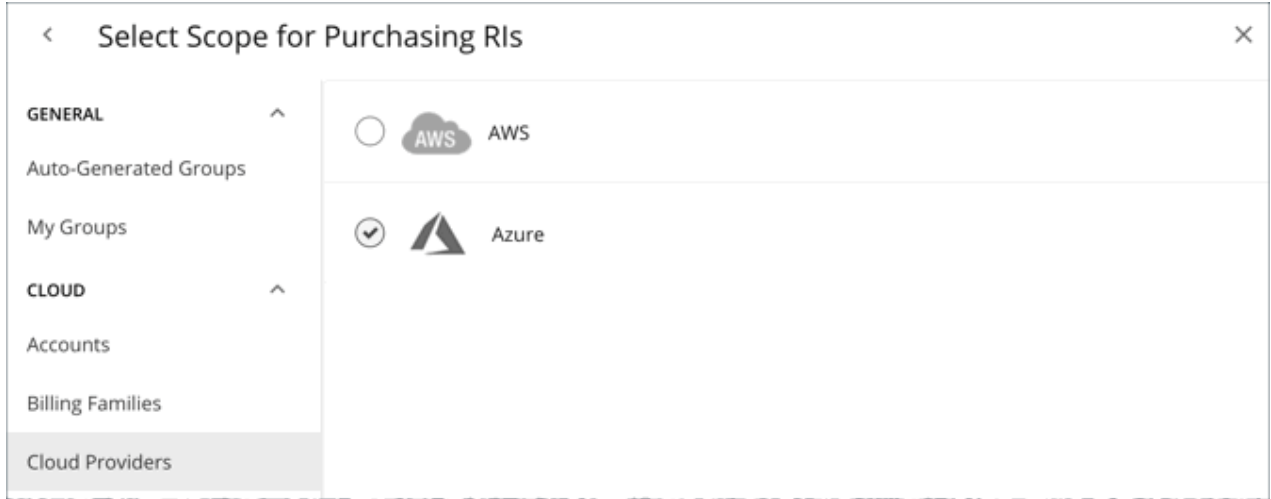
Run the Buy VM Reservations plan to see RI purchase opportunities that can significantly reduce on-demand costs for your cloud VMs. When calculating RI purchases, Turbonomic evaluates all RI purchasing

options for your selected scope and usage data for the VMs in that scope. It then compares your current costs to the costs you would get after executing the plan recommendations.

Configuring a Buy VM Reservations Plan

For an overview of setting up plan scenarios, see [Setting Up Plan Scenarios](#).

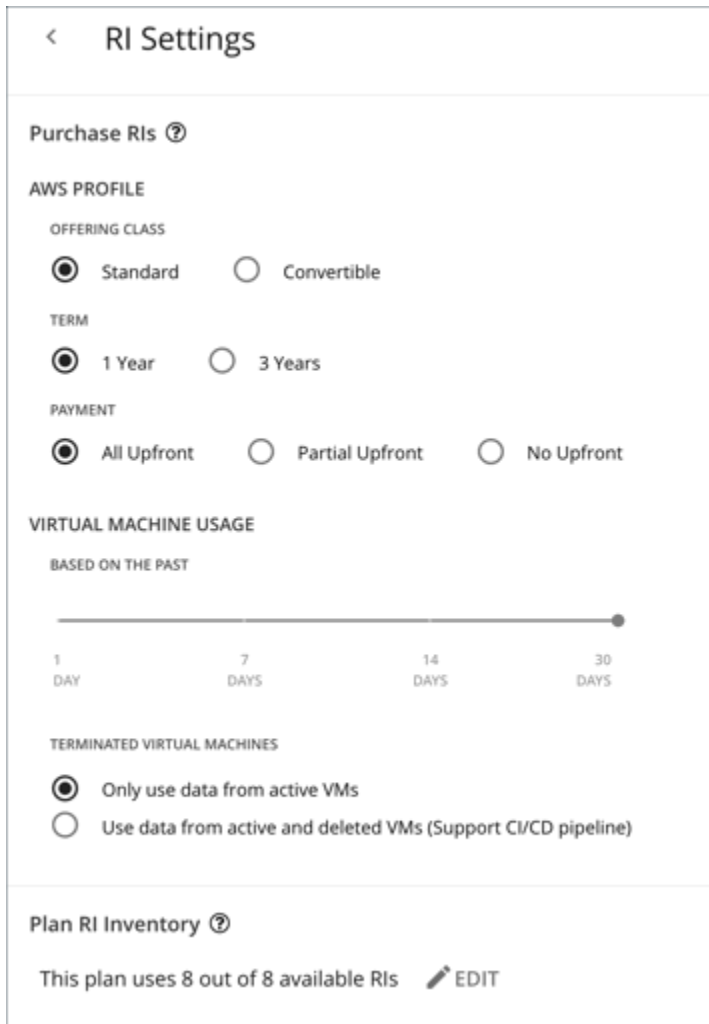
1. Scope



You can scope by:

- Accounts
Choose AWS accounts or Azure subscriptions for the plan's scope.
- Billing Families
Include RI purchases for a billing family. The plan calculates RI purchases through the billing family's master account.
- Cloud Providers
See purchase opportunities for your AWS or Azure environment.
- Regions
Focus the plan on a cloud provider's region.

2. RI Settings



< RI Settings

Purchase RIs ?

AWS PROFILE

OFFERING CLASS

☒ Standard ☐ Convertible

TERM

☒ 1 Year ☐ 3 Years

PAYMENT

☒ All Upfront ☐ Partial Upfront ☐ No Upfront

VIRTUAL MACHINE USAGE

BASED ON THE PAST

1 DAY 7 DAYS 14 DAYS 30 DAYS

TERMINATED VIRTUAL MACHINES

☒ Only use data from active VMs
☐ Use data from active and deleted VMs (Support CI/CD pipeline)

Plan RI Inventory ?

This plan uses 8 out of 8 available RIs [EDIT](#)

Purchase RI Settings

Allow the plan to buy Reserved Instances based on the following configurations:

- **Profile**

The settings that you have set up for real-time analysis are selected by default. You can change the settings to see how they affect costs. For more information, see [RI Purchase Profile](#).

- **Virtual Machine Usage**

Specify the time frame you want the plan to use when it calculates your RI purchases.

- **Terminated Virtual Machines**

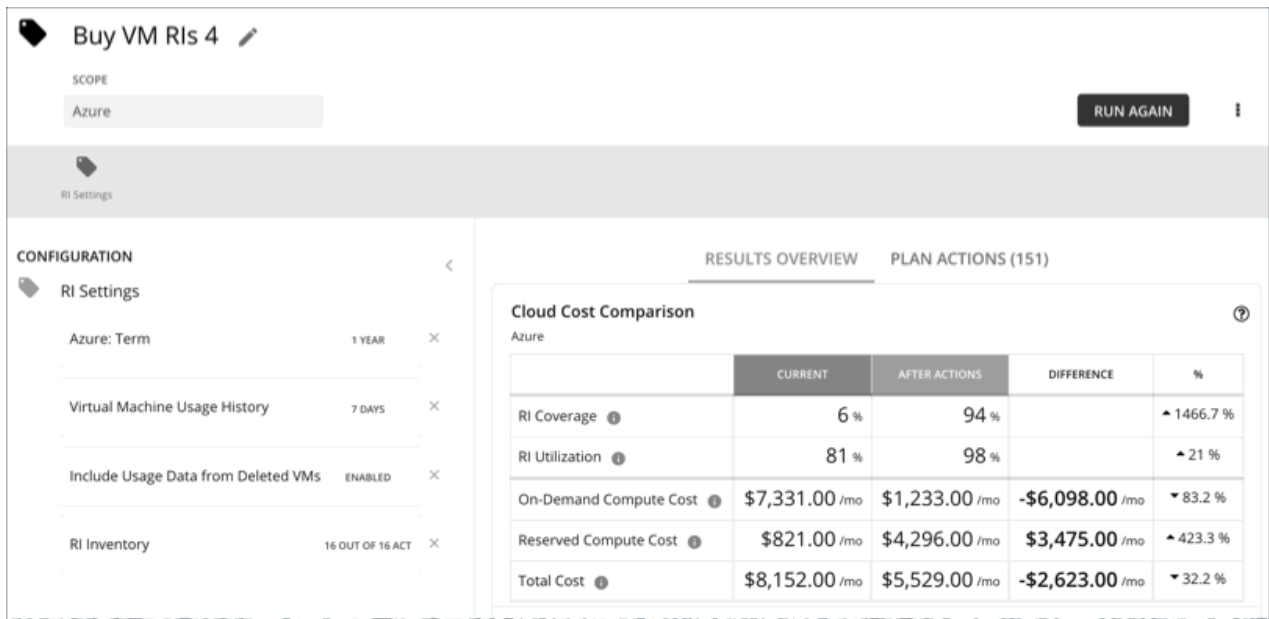
- **Only use data from active VMs** – Select this option if you terminate your VMs permanently.
- **Use data from active and deleted VMs (Support CI/CD pipeline)** – Select this option if you want to use data from a CI/CD pipeline that regularly deploys and terminates VMs.

Plan RI Inventory

Select your RI inventory for the plan. You can use the default selection or any of the available RIs for your scope.

Working With Buy VM Reservations Plan Results

After the Buy VM Reservations runs, you can view the results to see RI purchase and optimization opportunities for your cloud environment.



Viewing the Results

The plan results include the following charts:

- **Cloud Cost Comparison**

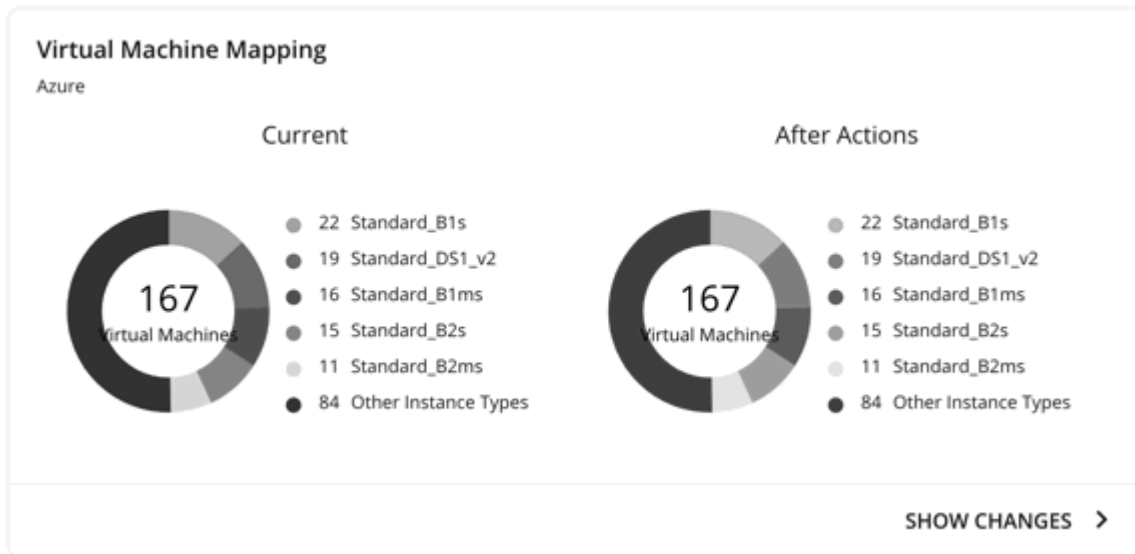
This chart highlights changes to your existing RI coverage and utilization if you execute all the actions that the plan recommends. Actions include increasing coverage or purchasing RIs. Your cloud provider will adjust RI allocations when the actions have completed.

- Analysis evaluates ways to increase your current RI coverage so you can take full advantage of discounted pricing offered through RIs.
- If you need more RI capacity to reduce your costs further, the plan will recommend RI purchase actions. The analysis looks at historical VM usage and uptime to arrive at the RI capacity you should purchase.

You can compare current and after-action costs, including on-demand compute, reserved compute, and total costs. Purchasing RIs increases your reserved compute cost, but can lower your on-demand compute cost significantly as RI coverage increases. The end result is a reduction to your total cost.

- **Virtual Machine Mapping**

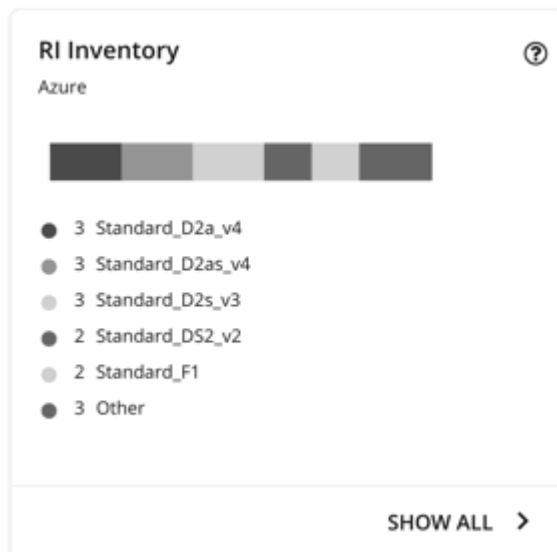
This chart shows the instance types for the VMs included in the plan.



Click **Show Changes** to see details for each VM with RI coverage changes. The table maps VMs to instance types, and shows how changes in RI coverage can reduce on-demand cost.

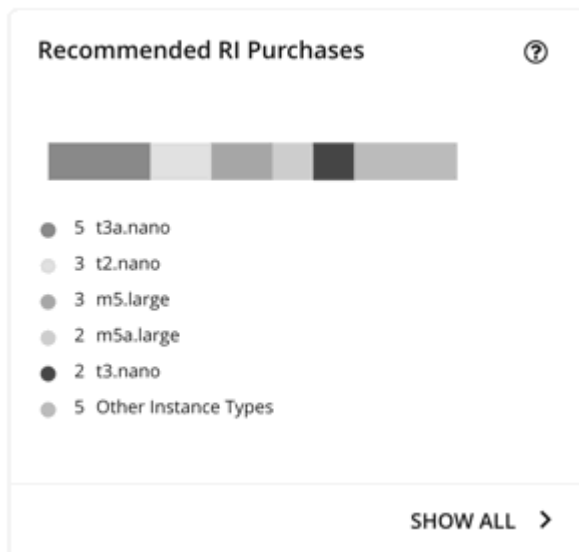
- **RI Inventory**

This chart shows the RIs that you have configured for the plan and lists them by instance types. For a tabular listing, click **Show All** at the bottom of the chart.



- **Recommended RI Purchases**

This chart lists the RIs the plan recommends you to purchase, including how many of each is needed.



Click **Show All** to see details for each RI. The table shows the properties, up-front cost, and break-even period for each RI investment. It also indicates the monthly savings you would realize when you buy a specific RI.

Viewing Plan Actions

Click the **Plan Actions** tab on top of the page to view a list of actions that you need to execute to achieve the plan results.

RESULTS OVERVIEW		PLAN ACTIONS (20)	
<input type="text" value="Search..."/>		FILTER	
Buy 1 t3.nano RIs for [redacted] in aws-US East (Ohio) Increase RI Coverage by 79%		EST. SAVINGS: \$0.404/mo	EFFICIENCY >
Buy 2 t3a.nano RIs for [redacted] in aws-US East (Ohio) Increase RI Coverage by 85%		EST. SAVINGS: \$2.03/mo	EFFICIENCY >
Buy 1 t3a.nano RIs for [redacted] in aws-US Eas...ia) Increase RI Coverage by 99%		EST. SAVINGS: \$1.37/mo	EFFICIENCY >

Re-Running the Plan

You can run the plan again with the same or a different set of configuration settings. This runs the plan scenario against the market in its current state, so the results you see might be different, even if you did not change the configuration settings.

Use the toolbar on top of the Configuration section to change the configuration settings.

- Purchase RI Settings

Update your purchase settings to see how they impact results. For example, you can configure a longer timeframe so that the plan can include additional VM usage data in its analysis. For details, see [Purchase RI Settings](#).

- Plan RI Inventory

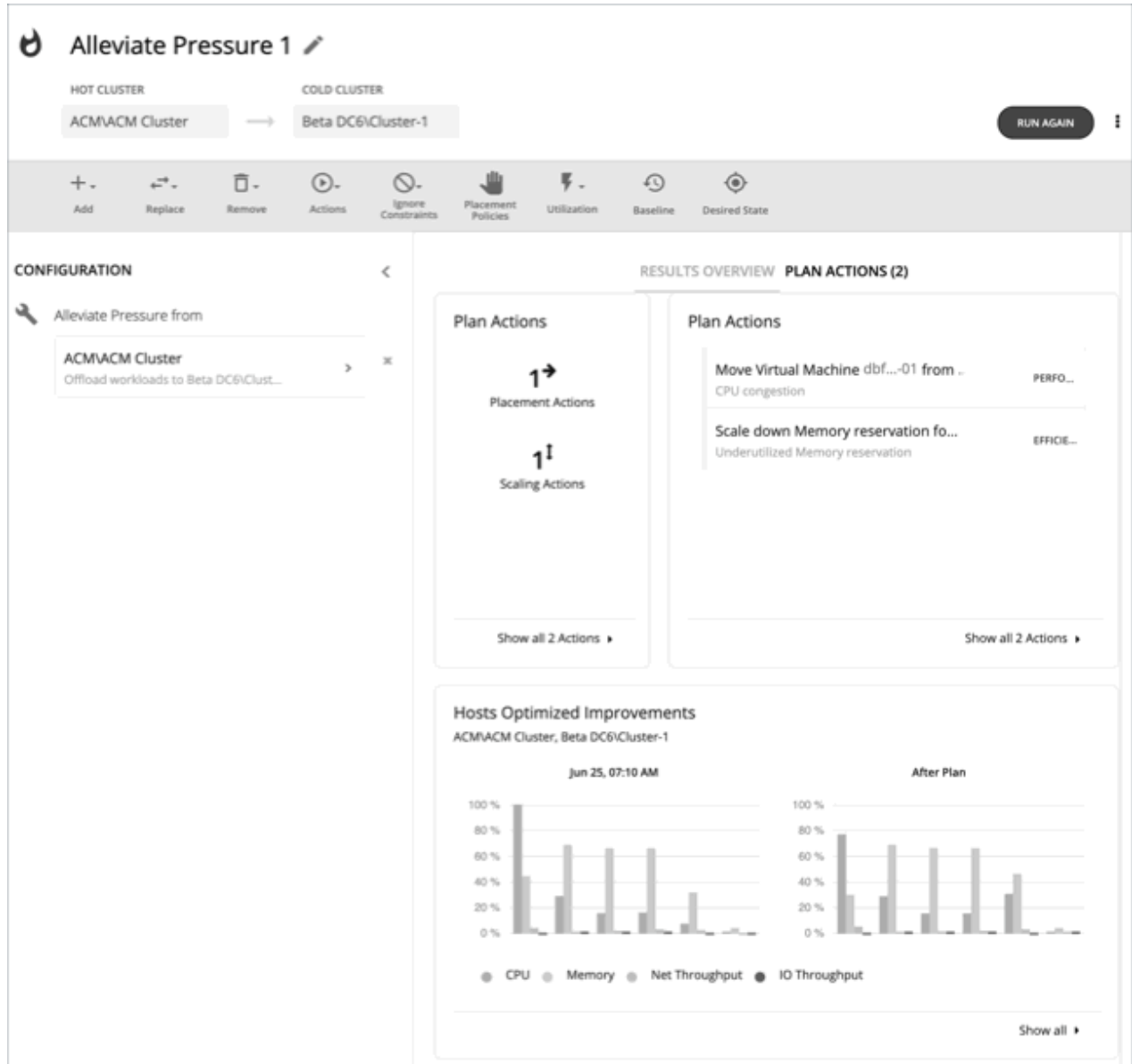
Use the default selection or any of the available RIs for your scope.

Note:

It is not possible to change the scope of the plan in the Plan Page. You will need to start over if you want a different scope. To start over, go to the top-right section of the page, click the More options icon (⋮), and then select **New Plan**.

When you are ready to re-run the plan, click **Run Again** on the top-right section of the page.

Alleviate Pressure Plan



Use the Alleviate Pressure plan to find out how to migrate workloads from a stressed or *hot* cluster over to a cluster with more headroom. This plan shows the minimal changes you need to make to reduce risks on the hot cluster.

The plan results:

- Show the actions to migrate workloads from the hot cluster to the cold one
- Compare the current state of your clusters to the optimized state
- Show resulting headroom for both the hot and the cold clusters

- Show trends of workload-to-inventory over time for both clusters

Alleviate Pressure plans make use of the headroom in your clusters. Headroom is the number of VMs the cluster can support, for CPU, Memory and Storage.

To calculate cluster capacity and headroom, Turbonomic runs nightly plans that take into account the conditions in your current environment. The plans use the Economic Scheduling Engine to identify the optimal workload distribution for your clusters. This can include moving your current VMs to other hosts within the given cluster, if such moves would result in a more desirable workload distribution. The result of the plan is a calculation of how many more VMs the cluster can support.

To calculate VM headroom, the plan simulates adding VMs to your cluster. The plan assumes a certain capacity for these VMs, based on a specific VM template. For this reason, the count of VMs given for the headroom is an approximation based on that VM template.

To specify the templates these plans use, you can configure the nightly plans for each cluster. For more information, see [Configuring Nightly Plans](#)

Note:

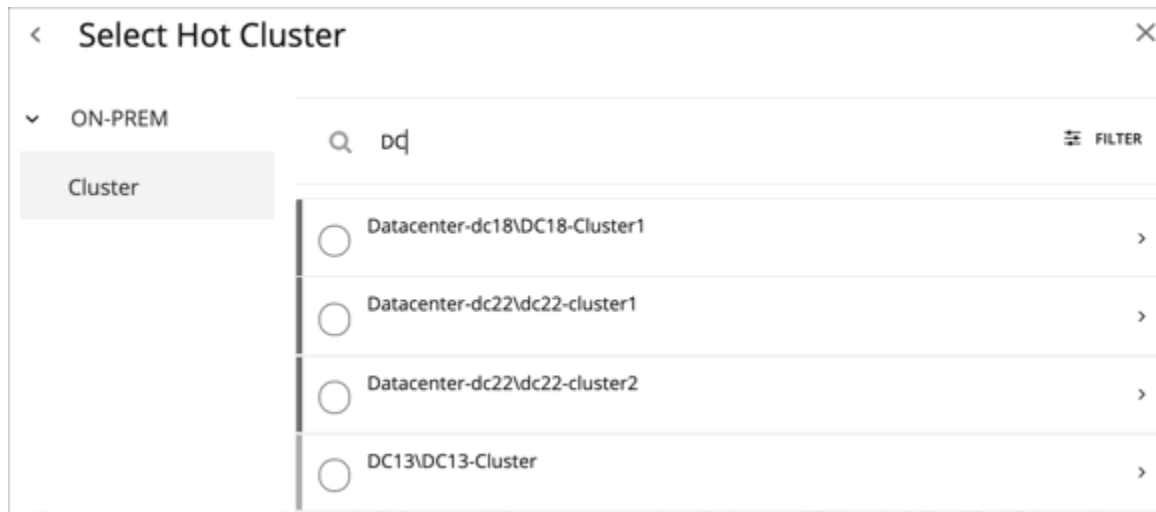
To execute, this plan must ignore certain constraints. The plan ignores cluster constraints to allow migrating workloads from the hot cluster to the cold one. It also ignores network constraints, imported DRS policies, and any Turbonomic that would ordinarily be in effect.

Configuring an Alleviate Pressure Plan

For an overview of setting up plan scenarios, see [Setting Up Plan Scenarios](#).

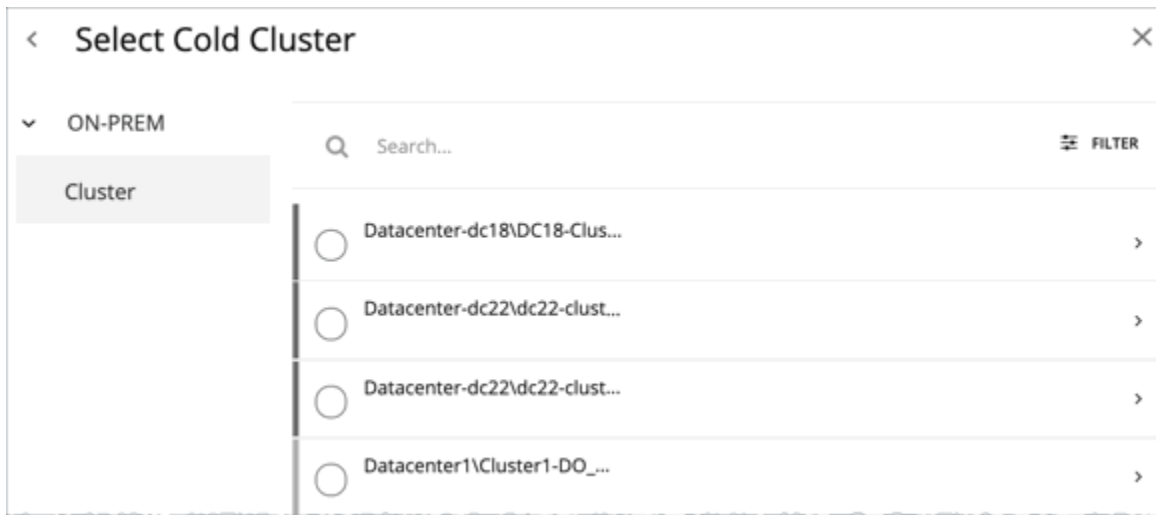
1. Scope

The wizard first gives you a list for you to choose the hot cluster. This is the cluster that shows risks to performance. The list sorts with the most critical clusters first, and it includes the calculated headroom for CPU, Memory, and Storage in each cluster.



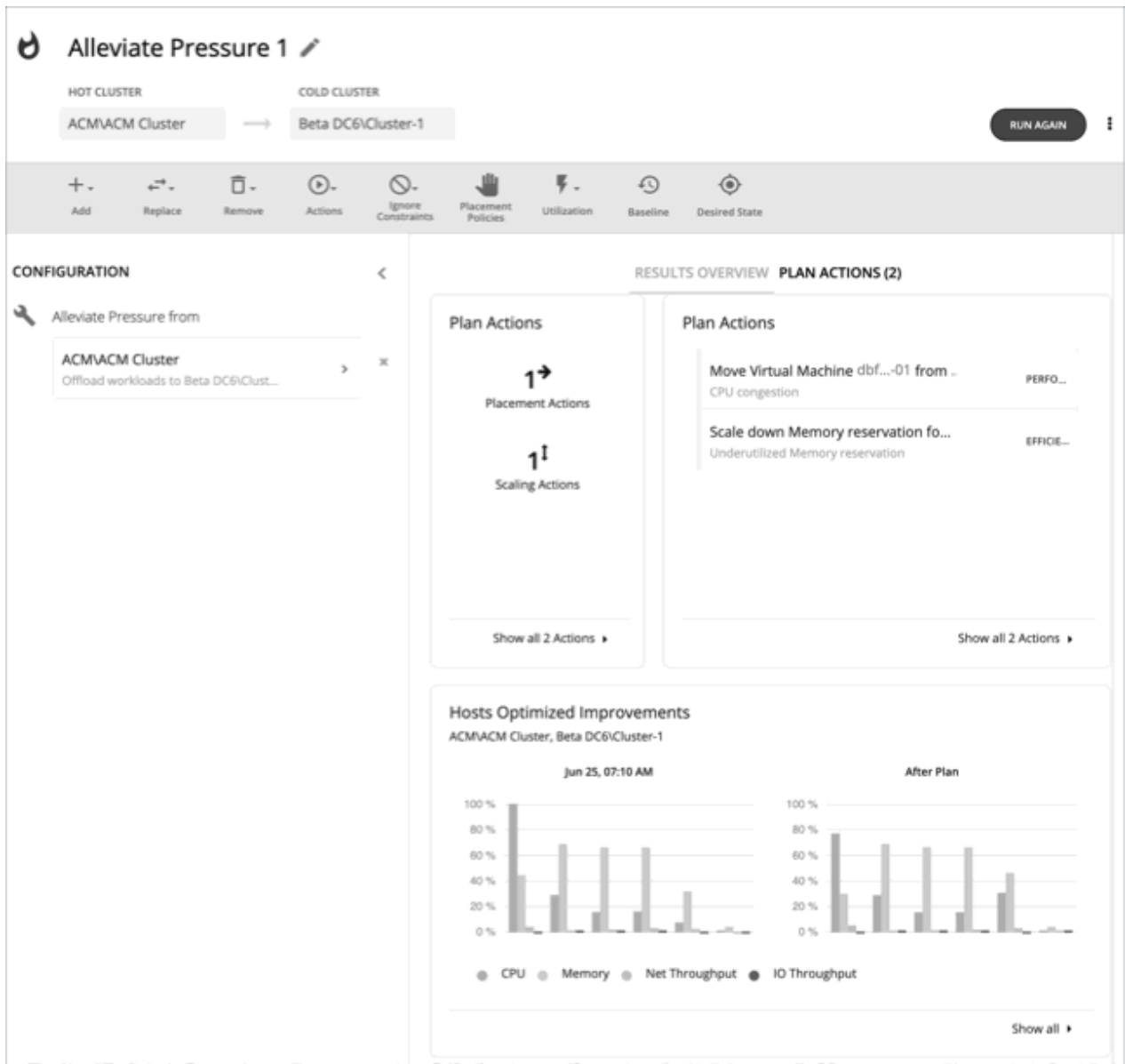
2. Cold Cluster

After you select the hot cluster, choose the cold cluster.



Working With Alleviate Pressure Plan Results

After the plan runs, you can view the results to see how the migration of workloads off of your hot cluster affects your environment.



Viewing the Results

The results include the following charts:

- Plan Actions

You can see a list of actions to reduce the pressure on the hot cluster. It's typical to see actions to move workloads from the hot cluster over to the cold cluster. If some VMs are overprovisioned, you might see actions to reduce the capacity for those workloads.

- Hosts Optimized Improvements

This chart compares the current state of the hot cluster to its state after executing the plan actions. It displays the resource utilization of the cluster's hosts both before and after the plan.

- Headroom

With these charts, you can compare the headroom between the hot and cold clusters.

- Virtual Machines vs Hosts and Storage

This chart shows the total number of virtual machines, hosts, and storage in your on-prem environment, and tracks the data over time. Chart information helps you understand and make decisions around capacity and utilization, based on historical and projected demand.

Re-Running the Plan

You can run the plan again with the same or a different set of configuration settings. This runs the plan scenario against the market in its current state, so the results you see might be different, even if you did not change the configuration settings.

Use the toolbar on top of the Configuration section to change the configuration settings.



The toolbar items that display are similar to the toolbar items for a custom plan. For details, see [Configuring a Custom Plan](#).

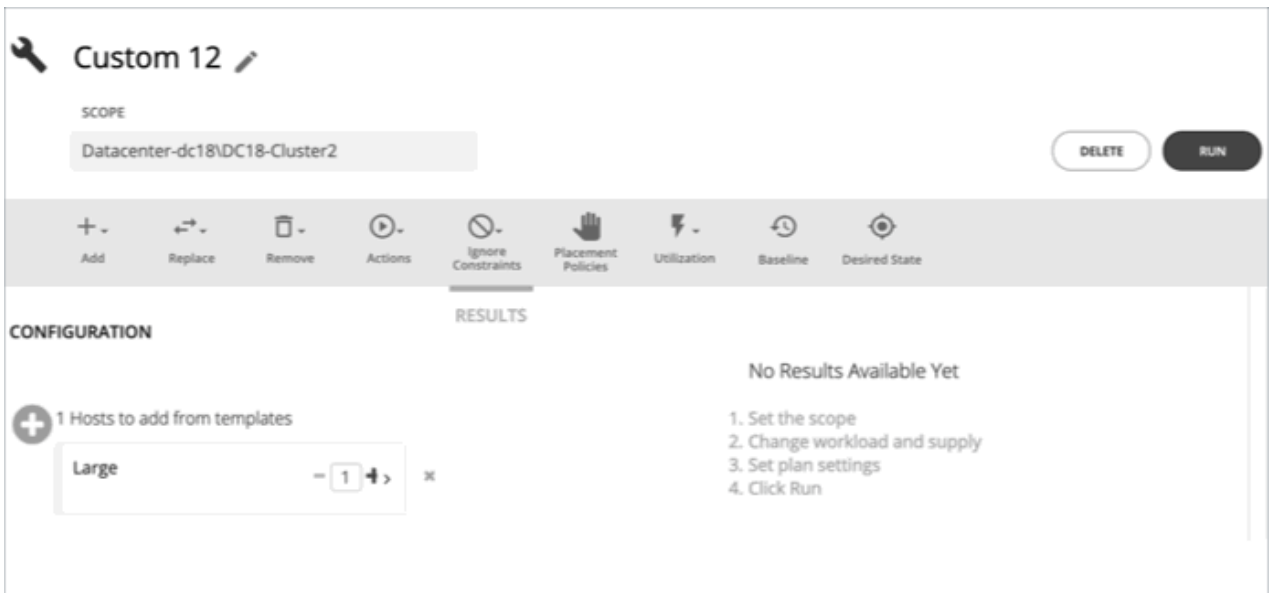
Note:

It is not possible to change the scope of the plan in the Plan Page. You will need to start over if you want a different scope. To start over, go to the top-right section of the page, click the More options icon (⋮), and then select **New Plan**.

When you are ready to re-run the plan, click **Run Again** on the top-right section of the page.

Custom Plan

For an overview of setting up plan scenarios, see [Settings Up User Plan Scenarios](#).



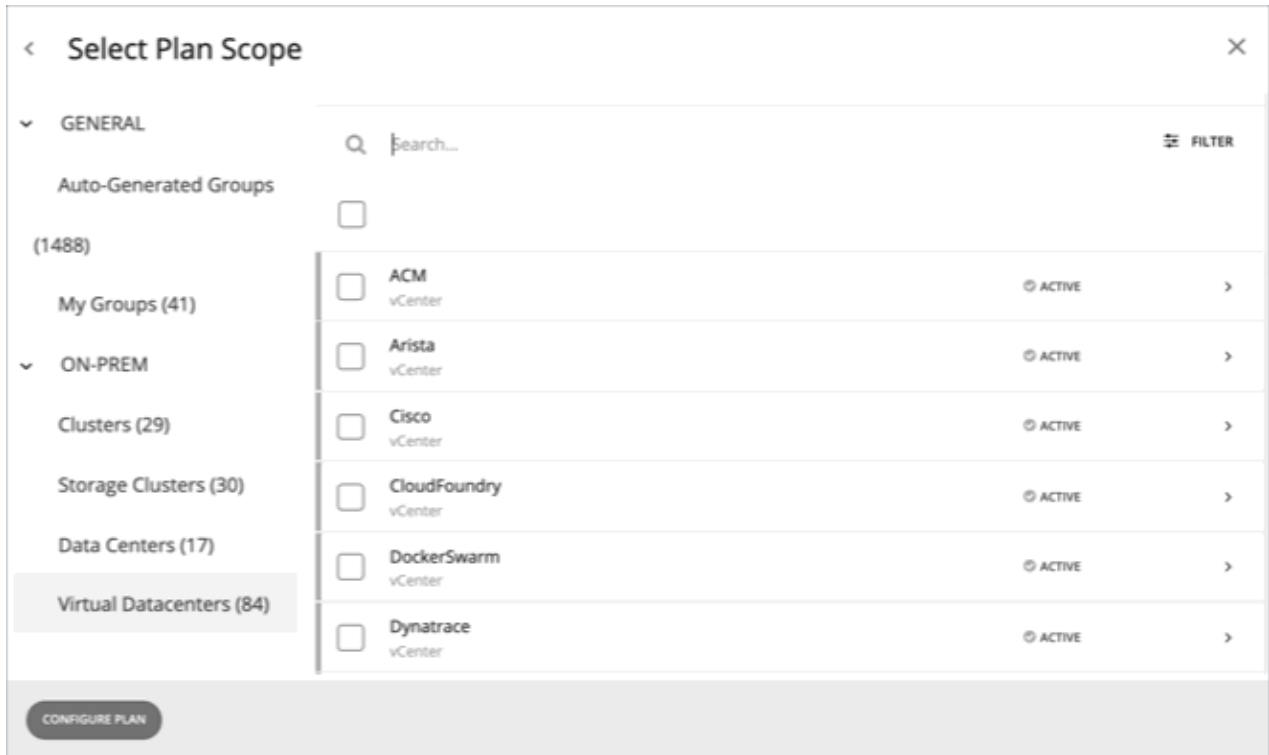
When you create a custom scenario, you specify the plan scope as an initial step, and then skip the plan wizards and jump straight into setting up the plan parameters. You can name the plan, change workload demand and the supply of resources, and specify other changes to the plan market.

Configuring a Custom Plan

For an overview of setting up plan scenarios, see [Setting Up Plan Scenarios](#).

1. Scope

Specify the plan scope and then click **Configure Plan** at the bottom of the page.



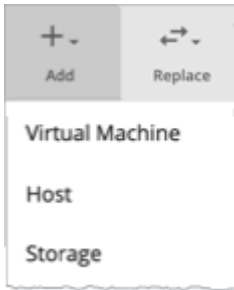
2. Plan Configuration

Use the Plan Configuration toolbar to fine-tune your plan settings. You can change workload demand and the supply of resources, and specify other changes to the plan market.



2.1. Add

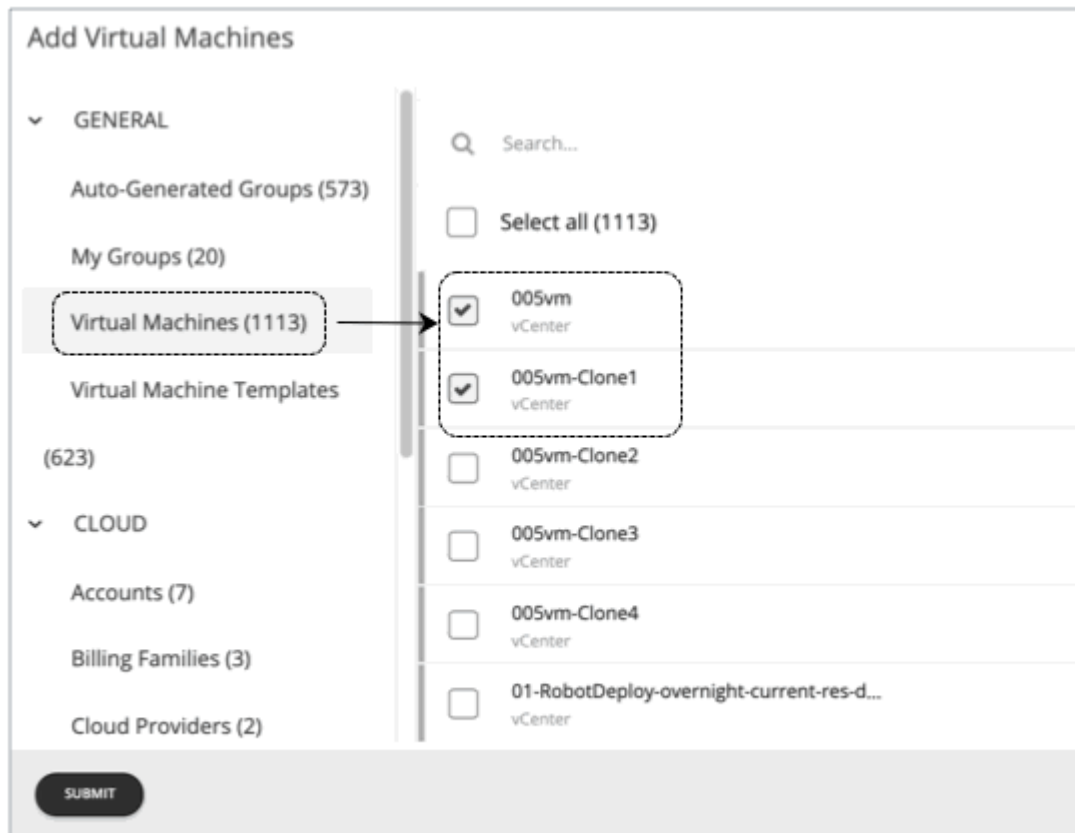
Add virtual machines, hosts, or storage to your plan. For example, when you add hosts, you increase the compute resources for the plan.



Copy from an Entity or Template

Choose an entity or template to copy. This describes the new entities that Turbonomic will add to the plan. For example, you can run a plan that adds new VMs to a cluster. If you copy from a template, then the plan adds a new VM that matches the resource allocation you have specified for the given template.

- Option 1: Copy from an entity



- Option 2: Copy from a template

If no existing template is satisfactory, create one by clicking **New Template**.



Note:

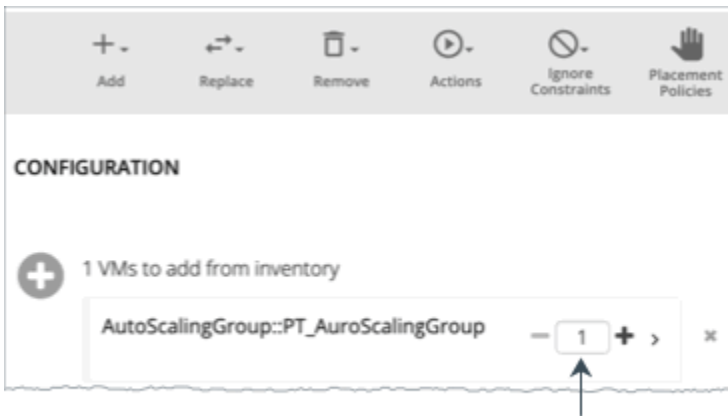
Turbonomic automatically adds any new template you create to the Template Catalog page (**Settings > Templates**).

It is not possible to use templates for containers or container pods.

Use the **Filter** option to show entities or templates with certain properties (name, number of CPUs, etc.). This makes it easier to sort through a long list.

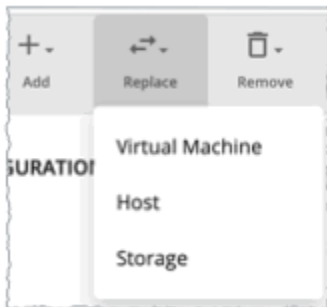
Number of Copies to Add

After choosing an entity or template, it appears as an entry in the Configuration summary. Then you can set how many copies to add.



Set how many copies to add

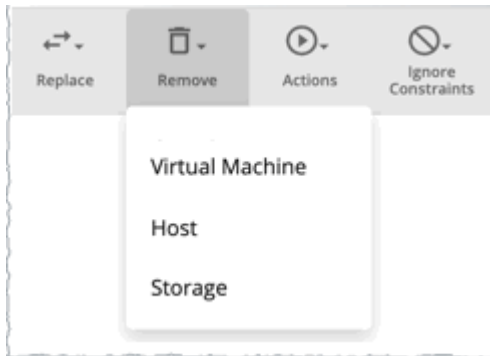
2.2. Replace



Replacing virtual machine is a way to change the properties of VMs in your plan market. When you replace workload, you select one or more VMs that you want to change, and then you select a template to use in their place. The list of changed VMs displays in the Configuration Summary. You can delete individual entries from the this summary if necessary.

Replacing hosts or storage is a way to plan for a hardware upgrade. For example, if you replace your hosts or datastores with a more powerful template, the plan might show that you can use fewer hosts or datastores, and it will show the best placement for workloads on those entities. You begin by selecting the entities you want to replace, and when you click **REPLACE** you can then choose a template that will replace them. Note that you can only choose a single template for each set of entities you want to have replaced. You can configure different replacements in the same plan, if you want to use more than one template.

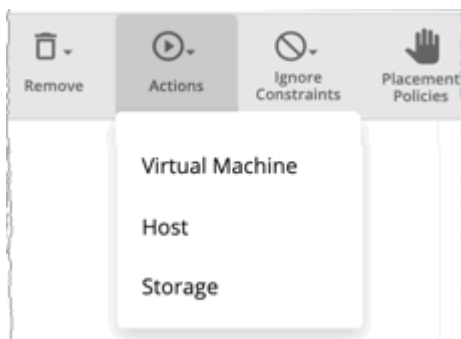
2.3. Remove



Removing virtual machines frees up resources for other workloads to use.

Removing hosts or storage means you have fewer compute or storage resources for your workloads. If you think you have overprovisioned your environment, you can run a plan to see whether fewer hosts or less storage can still support the same workload.

2.4. Actions



See the effect of enabling or disabling actions on the entities included in the plan. For example, you might plan for more workload but know that you don't want to add more hardware, so you disable Provision of hosts for your plan. The results would then indicate if the environment can support the additional workload.

2.5. Ignore Constraints

Choose to ignore constraints (such as placement policies) for VMs in your environment.



By default, VMs are constrained to the cluster, network group, datacenter, or storage group that their hosts belong to. You can choose to ignore these boundaries.

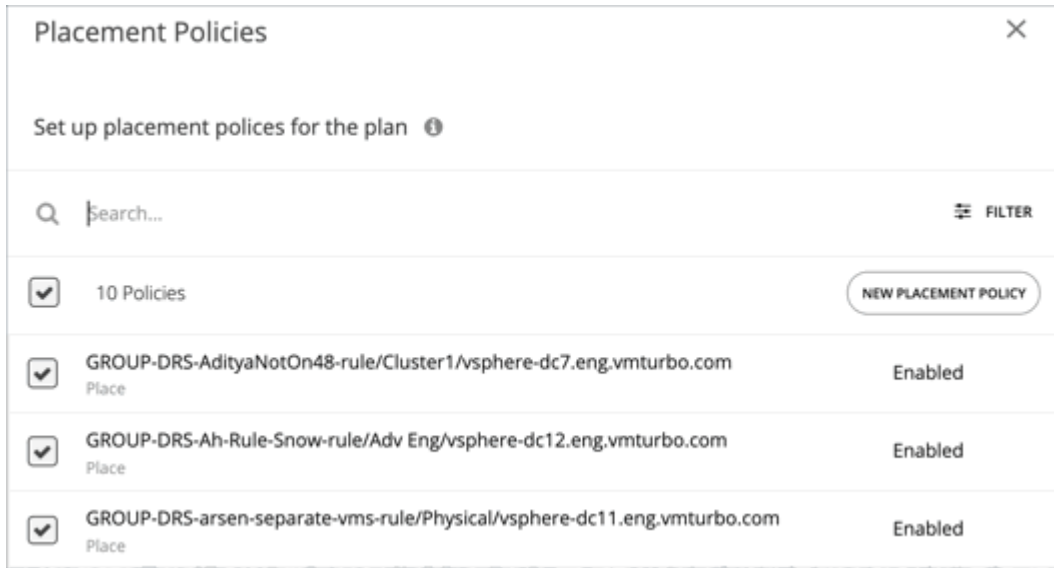
For example, by default a plan does not consider moving VMs to physical hosts outside of the current cluster. If you disable the Cluster constraint for a VM in your plan, then the plan can evaluate the results of hosting those VMs on any other physical machine within the scope of your plan. If the best results come from moving that VM to a different cluster, then the plan will show that result.

Note:

If you are adding hosts to a plan, and use host templates, then you must turn on **Ignore Constraints**.

2.6. Placement Policies

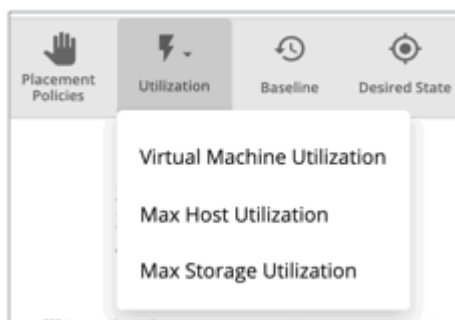
By default, the plan includes all the placement policies that apply to the plan scope. Also, these policies are in their real-time state (enabled or disabled).



You can use these settings to enable or disable existing policies, or you can create new policies to apply only to this plan scenario. For information about creating placement policies, see [Placement Policies](#).

2.7. Utilization

Setting utilization by a certain percentage is a way to increase or decrease the workload for the scope of your plan and any entity added to the plan, or for specific groups. Turbonomic uses the resulting utilization values as the baseline for the plan.



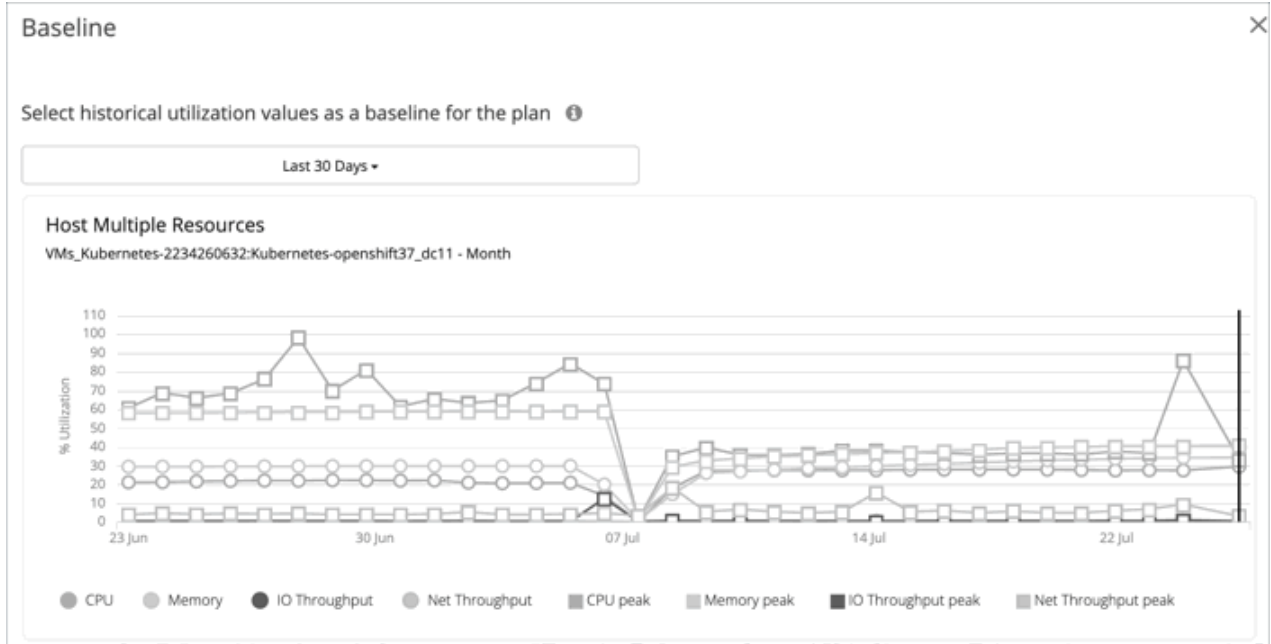
Max Host Utilization levels specify the percentage of the physical resource that you want to make available in the given plan. By default, hosts have utilization set to 100%. For a given plan, you can set the utilization to a lower value. For example, assume you want to simulate High Availability of 25% for some hosts in the plan. In that case, you can select these hosts and set their utilization levels to 75%.

Max Storage utilization levels specify the percentage of the physical resource that you want to make available in the given plan. By default, storage has utilization set to 100%. For a given plan, you can set the utilization to a lower value. For example, assume you have one data store that you want to share

evenly for two clusters of VMs. Also assume that you are creating a plan for one of those clusters. In that case, you can set the datastores to 50% utilization. This saves storage resources for the other cluster that will use this storage.

2.8. Baseline

Use these settings to set up the baseline of utilization metrics for your plan.

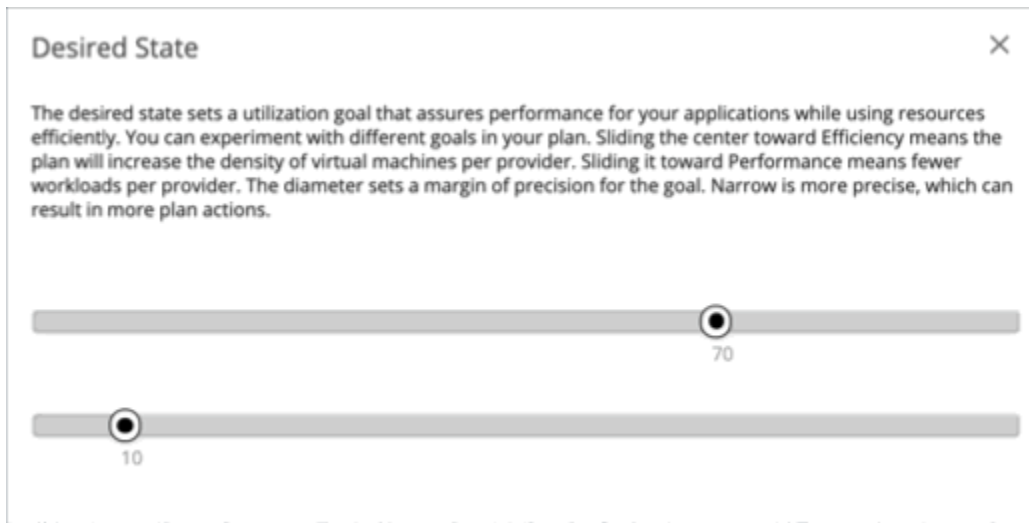


By default, the plan runs against the current state of your environment. You can set up the plan to add or remove entities, or otherwise affect the plan calculations. But the utilization metrics will be based on the current state of the plan. If you run the same plan multiple times, each run begins with a fresh view of your inventory.

You can select from the list of snapshots to load the utilization statistics from a previous time period into the plan. Use this to run the plan against utilization that you experienced in the past. For example, assume a peak utilization period for the month before the winter holidays. During the holidays you want to plan to add new capacity that can better handle that peak. You would set the baseline to the utilization you saw during that pre-holiday peak.

2.9. Desired State

The desired state is a condition in your environment that assures performance for your workloads, while it utilizes your resources as efficiently as possible and you do not overprovision your infrastructure. Turbonomic uses default Desired State settings to drive its analysis. You should never change the settings for real-time analysis unless you are working directly with Technical support. However, you can change the settings in a plan to see what effect a more or less aggressive configuration would have in your environment.



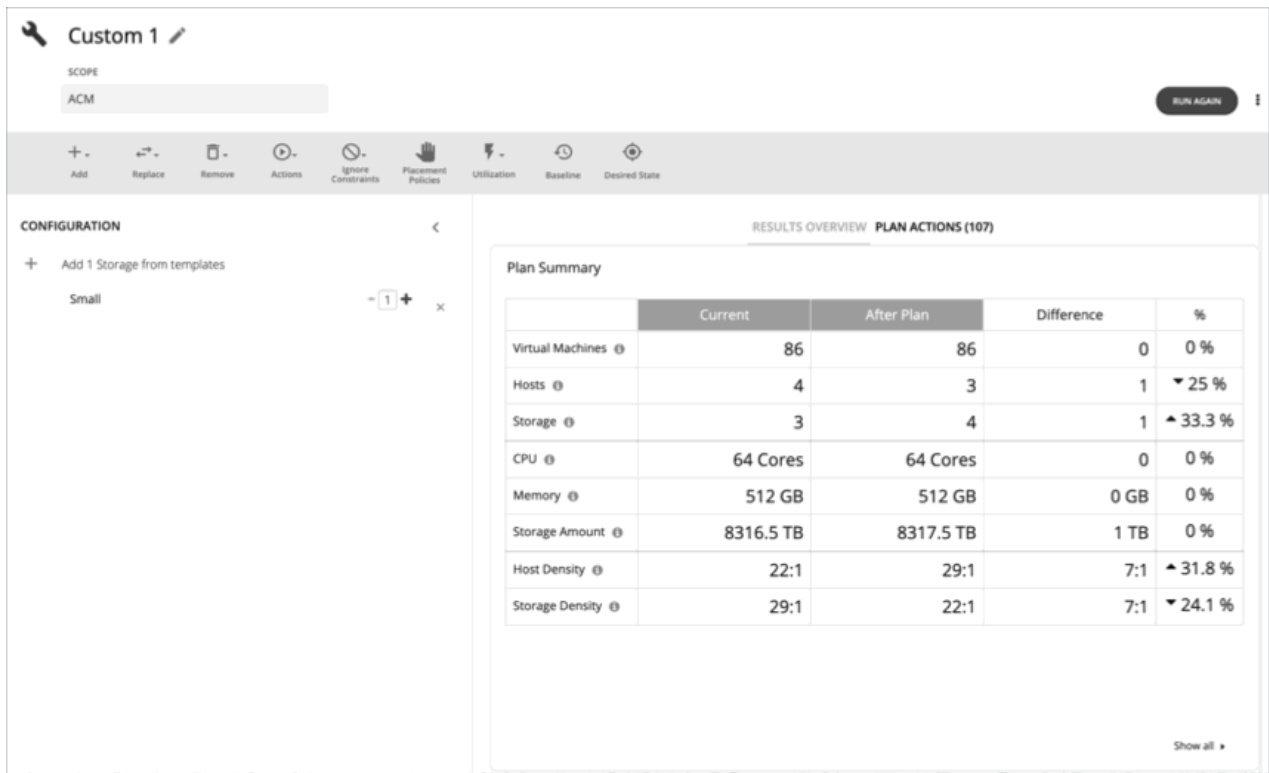
You can think of the desired state as an n-dimensional sphere that encompasses the fittest conditions your environment can achieve. The multiple dimensions of this sphere are defined by the resource metrics in your environment. Metric dimensions include VMem, storage, CPU, etc. While the metrics on the entities in your environment can be any value, the desired state, this n-dimensional sphere, is the subset of metric values that assures the best performance while achieving the most efficient utilization of resources that is possible.

The Desired State settings center this sphere on Performance (more infrastructure to supply the workload demand), or on Efficiency (less investment in infrastructure to supply the workload demand). The settings also adjust the diameter of the sphere to determine the range of deviation from the center that can encompass the desired state. If you specify a large diameter, Turbonomic will have more variation in the way it distributes workload across hosting devices.

For more information, see [The Desired State](#).

Working With Custom Plan Results

After the plan runs, you can view the results to see how the plan settings you configured affect your environment.



Viewing the Results

The results include the following charts:

- **Plan Summary Chart**

This chart compares your current resources to the resources you would get after executing the plan.

Note:

Under some circumstances, this chart might not count "non-participating" entities in the real-time market, such as suspended VMs or hosts in a failover state. The following charts, on the other hand, count all entities in the real-time market, regardless of state:

- Scope Preview chart (displays before you run the plan)
- Optimized Improvements and Comparison charts

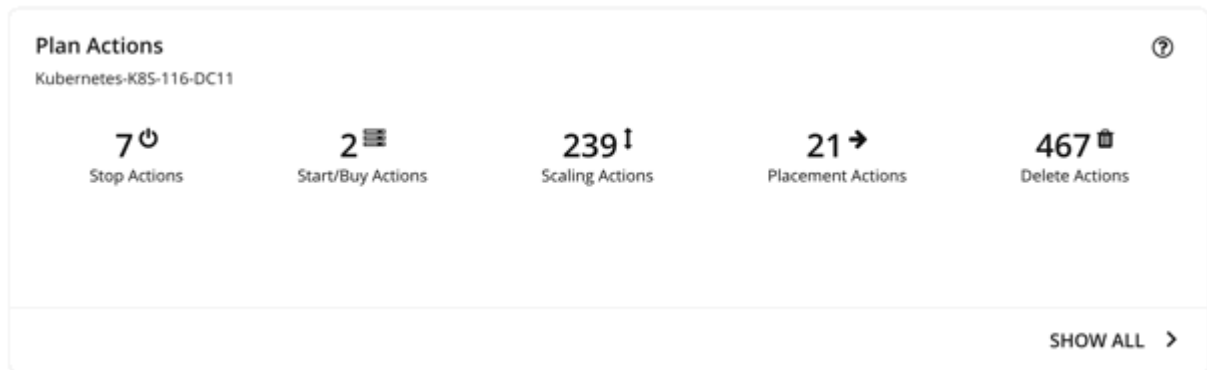
If the plan's scope includes VMs that cannot be placed, the results include a notification indicating the number of VMs. Click **Show Details** to see the list of VMs and the reasons for their non-placement.

Click **Show all** at the bottom of the chart to see savings or investment costs, or to download the chart as a CSV file.

- **Plan Actions Chart**

This chart summarizes the actions that you need to execute to achieve the plan results. For example, if you run an Alleviate Pressure plan, you can see actions to move workloads from the hot cluster over to the cold cluster. If some VMs are overprovisioned, you might see actions to reduce the capacity for those workloads.

The text chart groups actions by action type. The list chart shows a partial list of actions.

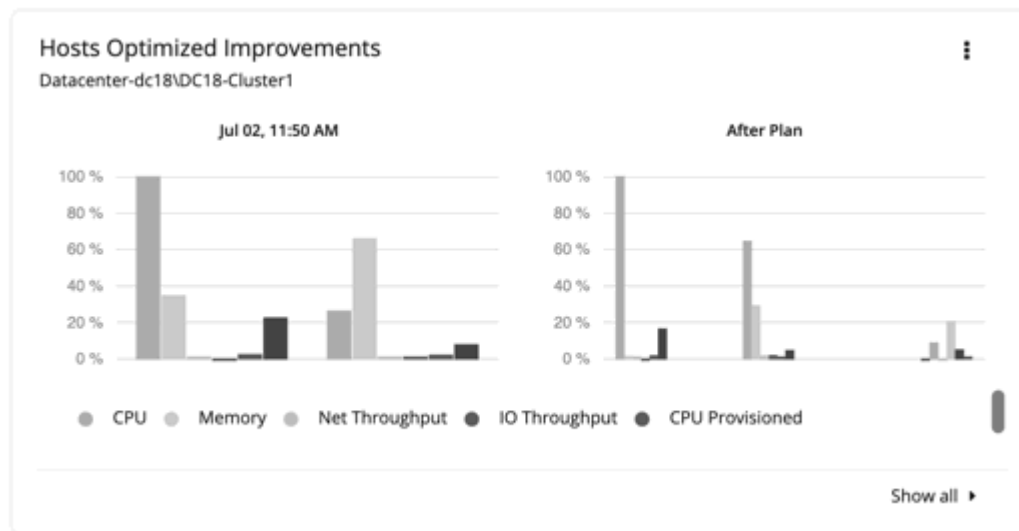


To view action details or download the list of actions as a CSV file:

- Click an action type in the text chart or an individual action in the list chart.
- Click **Show All** at the bottom of the chart.

• **Optimized Improvements Charts for Hosts, Storage, and Virtual Machines**

The Optimized Improvements chart shows how the utilization of resources would change assuming you accept all of the actions listed in the Plan Actions chart.



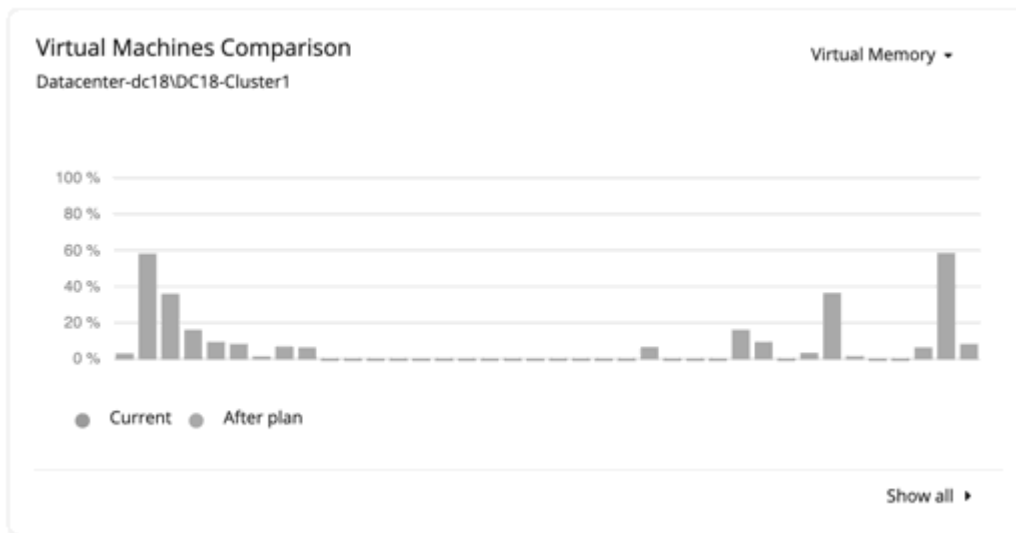
- In many of these charts, you can change the commodities on display. To do this, go to the top-right section of the chart, click the More options icon (⋮), and then select **Edit**. In the new screen that displays, go to the **Commodity** section and then add or remove commodities.

To restore the default commodities, use the **Reset view** option at the top-right section of the page.


- Click **Show all** at the bottom of the chart to see a breakdown of the current chart data by entity (for example, show CPU, Memory, and IO Throughput utilization for each host), or to download chart data as a CSV file.

• **Comparison Charts for Hosts, Storage Devices, and Virtual Machines**

A Comparison chart shows how the utilization of a particular commodity (such as memory or CPU) for each entity in the plan would change if you execute the actions listed in the Plan Actions chart.



- To change the commodity displayed in the chart, go to the top-right section of a chart and then select from the list of commodities.

To restore the default commodity, go to the top-right section of the page, click the More options icon (), and then select **Reset view**.

- Click **Show all** at the bottom of the chart to show a breakdown of the current chart data by entity (for example, show Virtual Memory utilization for each virtual machine), or to download the chart as a CSV file.

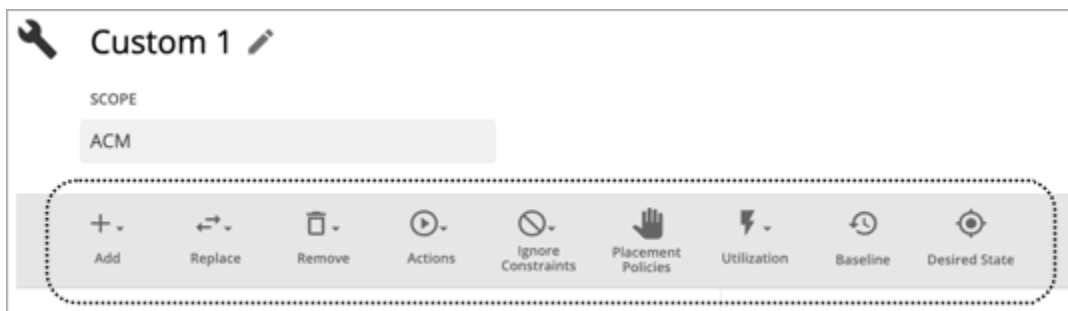
Note:

For the Storage Devices Comparison chart, if you set the view to **VM Per Storage** and click **Show all**, the total number of VMs sometimes does not match the number in the Plan Summary chart. This happens if there are VMs in the plan that use multiple storage devices. The Storage Devices Comparison chart counts those VMs multiple times, depending on the number of storage devices they use, while the Plan Summary chart shows the actual number of VMs.

Re-Running the Plan


You can run the plan again with the same or a different set of configuration settings. This runs the plan scenario against the market in its current state, so the results you see might be different, even if you did not change the configuration settings.

Use the toolbar on top of the Configuration section to change the configuration settings.



For details about these settings, see [Configuring a Custom Plan](#).

Note:

It is not possible to change the scope of the plan in the Plan Page. You will need to start over if you want a different scope. To start over, go to the top-right section of the page, click the More options icon (), and then select **New Plan**.

When you are ready to re-run the plan, click **Run Again** on the top-right section of the page.

Configuring Nightly Plans

The plan and its template

Expand to see template details

IO THROUGHPUT SIZE	NETWORK THROUGHPUT SIZE	NUM OF CPU
0 MB/s	0 MB/s	1
CPU SPEED	CPU CONSUMED FACTOR	MEMORY SIZE
3465 MHz	0 %	1243.0769 MB
MEMORY CONSUMED FACTOR	IO THROUGHPUT CONSUMED	NETWORK THROUGHPUT CONSUMED
0 %	0 MB/s	0 MB/s
DISK SIZE	DISK IOPS CONSUMED	DISK CONSUMED FACTOR
1.344238 GB	0	20.701876 %

AVG:GROUP-PMsByCluster_vsphere-dc18.corp.vmturbo.com_datacenter-21_domain-c567_HEADROOM

MODEL

Turbonomic runs nightly plans to calculate headroom for the clusters in your on-prem environment. For each cluster plan, you can set which VM template to use in these calculations.

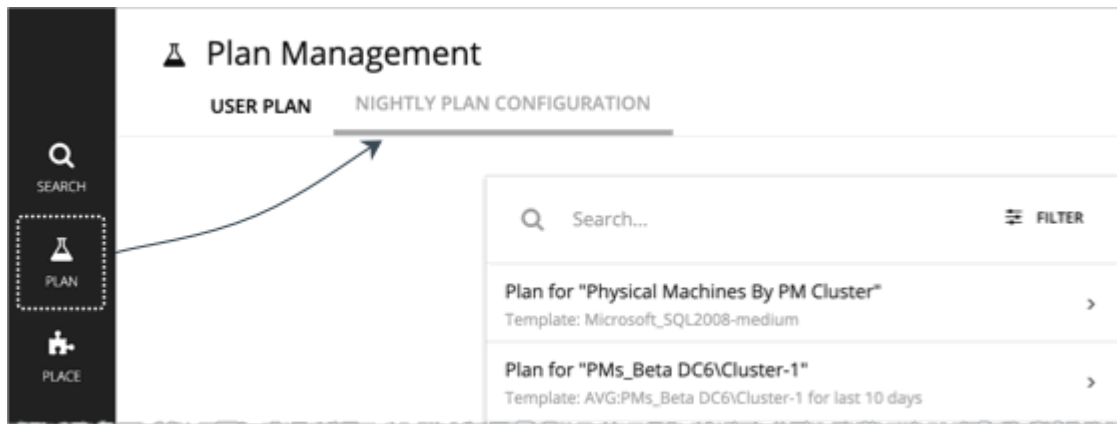
For information about viewing cluster headroom, see [Viewing Cluster Headroom](#).

To calculate cluster capacity and headroom, Turbonomic runs nightly plans that take into account the conditions in your current environment. The plans use the Economic Scheduling Engine to identify the optimal workload distribution for your clusters. This can include moving your current VMs to other hosts within the given cluster, if such moves would result in a more desirable workload distribution. The result of the plan is a calculation of how many more VMs the cluster can support.

To calculate VM headroom, the plan simulates adding VMs to your cluster. The plan assumes a certain capacity for these VMs, based on a specific VM template. For this reason, the count of VMs given for the headroom is an approximation based on that VM template.

To set templates to use for the nightly plans:

1. Navigate to the Plan Page and click **NIGHTLY PLAN CONFIGURATION**.



This displays a list of all the nightly plans. Turbonomic creates a nightly plan for each cluster.

2. Click the plan that you want to configure.

A fly-out appears that lists all the available templates.

3. Select the template you want for this plan.

Choose the template and click **Select**.

Place: Reserve Workload Resources

From the Workload Placement Page, you can set up reservations to save the resources you will need to deploy VMs at a future date. Turbonomic calculates optimal placement for these VMs and then reserves the host and storage resources that they need.

To reserve VMs, you will need to choose a VM template, specify any placement constraints, set how many instances to reserve, and then indicate whether to reserve now or in the future. Because reserved VMs do not yet exist, they do not participate in the real-time market.

About VM Templates for Reservations

VM templates specify the resource requirements for each reserved VM, including:

- Compute and storage resources allocated to each VM
- Consumed factor. This is the percentage of allocated CPU, memory, or storage that the reserved VM will utilize.

For more information about these templates, see [VM Template Settings](#).

About Placement of Reserved VMs

To determine the best placement for the VMs you want to reserve, Turbonomic runs a plan using the last-generated data in nightly-run headroom plans.

Note:

If you have changed your environment by adding targets or changing policies, wait until the next run of headroom plans for the affected scope before you create reservations.

When making placement decisions, Turbonomic considers the following:

- Placement constraints set in the reservation
- Demand capacity

Turbonomic calculates demand based on the *resource allocation* and *consumed factor* set in VM templates. For example, if you want to create a reserved VM from a template that assigns 3 GB of virtual memory and a consumed factor of 50%, Turbonomic calculates 1.5 GB of demand capacity for the reservation.

- Overprovisioned capacity

For reserved VMs, this corresponds to the resource allocation set in VM templates. Continuing from the previous example, Turbonomic assumes 3 GB of overprovisioned capacity for a reserved VM created from a template that assigns 3 GB of virtual memory.

For providers (hosts and storage), Turbonomic calculates overprovisioned capacity. The default overprovisioned capacity is 1000% for host Mem and CPU, and 200% for storage. A host with 512 GB of memory will have an overprovisioned capacity of 5 TB (5120 GB).

Providers must have sufficient *demand* and *overprovisioned* capacity to place a reservation. Turbonomic analyzes the current and historical utilization of cluster, host, and storage resources to identify viable providers for the VMs when they are deployed to your on-prem environment. In this way, Turbonomic can prevent congestion issues after you deploy the VMs.

Note:

Turbonomic persists historical utilization data in its database so it can continue to calculate placements accurately when market analysis restarts.

The initial placement attempt either succeeds or fails.

- Successful Initial Placements

If the initial placement attempt is successful, Turbonomic adds the reserved VM to your inventory.

In the previous example, a reserved VM that requires 1.5 GB of demand capacity and 3 GB of overprovisioned capacity can be placed on a host with 512 GB of memory (5 TB of overprovisioned capacity), assuming no constraints will prevent the placement.

Note that *actual* and *reserved* VMs share the same resources on providers. This means that provider capacity will change as demand from the actual VMs changes. Turbonomic polls your environment once per day to identify changes in provider capacity. It then evaluates if it can continue to place the reserved VMs *within the same cluster*, and then shows the latest placement status.

For example, if the host for a reserved VM is congested at the time of polling, Turbonomic might decide to move the VM to another host in the cluster that has sufficient capacity. In this case, the placement status stays the same (**Reserved**). Should you decide to deploy the VM at that point, you need to deploy it to the new host. If, on the other hand, there is no longer a suitable host in the cluster, the placement fails and the status changes to **Placement Failed**. Deploying the VM at that point will result in congestion. Turbonomic will *not* retry fulfilling the reservation.

- Failed Initial Placements

If the initial placement attempt is unsuccessful (for example, if all providers have seen historical congestion), Turbonomic shows that the placement has failed and will *not* retry fulfilling the reservation.

Current and Future Reservations

You can create a current or future reservation from the Workload Placement Page.

- Current Reservation

Turbonomic calculates placement immediately and then adds the reserved VMs to your inventory if placement is successful.

This reservation stays in effect for 24 hours, or until you delete it.

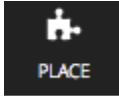
- Future Reservation

Set the reservation for some time in the future.

Turbonomic does not calculate placement at this time — the future reservation saves the definition, and Turbonomic will calculate placement at the time of the reservation start date.

This reservation stays in effect for the duration that you set, or until you delete it.

Displaying the Workload Placement Page



To see the reservations that are currently in effect and to create new reservations, click the **PLACE** button in the Navigation Menu.

ALL RESERVATIONS

Workload Placement
Workload Placement

[CREATE RESERVATION](#)

[FILTER](#)

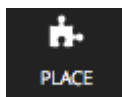
<input type="checkbox"/>	5 Reservations	
<input type="checkbox"/>	Cud_GiantVM Cud_GiantVM 2/7/2020 - 3/7/2020 PLACEMENT_FAILED "GiantVM"	PLACEMENT F... >
<input type="checkbox"/>	CudMultipleVMs 10 "Hatice_VM" placed on HawthorneDev	RESERVED >
<input type="checkbox"/>	CudRes4 2 "Hatice_VM" placed on HawthorneDev	RESERVED >
<input type="checkbox"/>	CudRes5 1 "Hatice_VM" placed on HawthorneDev	RESERVED >
<input type="checkbox"/>	MyReservation MyReservation 2/7/2020 - 3/7/2020 RESERVED "Hatice_VM"	RESERVED >

Creating a Reservation

Reservations set aside resources for anticipated workload. While a reservation is in the RESERVED state, Turbonomic continually calculates placement for the reserved VMs.

To create a reservation:

1. Navigate to the Workload Placement page.



2. Create a new reservation.

[CREATE RESERVATION](#)

In the Workload Placement page, click **CREATE RESERVATION**.

Turbonomic displays a list of templates. Choose the template you want, and click **NEXT: CONSTRAINTS**.

3. Optionally, specify placement constraints.

In the **Constraints** section and choose which constraints to apply to this reservation.

Constraints are optional, but note that these constraints are how you ensure that the template you have chosen is viable in the given locations that Turbonomic will choose.

The constraints you can choose include:

- Scope

Choose the datacenter or host cluster that you will limit the reservation to.

- Placement Policy

This list shows all the placement policies have been created as **Turbonomic Segments**. Choose which placement policies the reservation will respect.

- Networks

Turbonomic discovers the different networks in your environment. Use this constraint to limit workload placement to the networks you choose.

When you are done setting constraints, click **NEXT: RESERVATION SETTINGS**.

4. Make the reservation settings, and create the reservation.

To finalize the reservation, make these settings:

- RESERVATION NAME

The name for the reservation. You should use unique names for all your current reservations.

This name also determines the names of the reservation VMs that Turbonomic creates to reserve resources in your environment. For example, assume the name *MyReservation*. If you reserve three VMs, then Turbonomic creates three reservation VMs named *MyReservation_0*, *MyReservation_1*, and *MyReservation_2*.

- VIRTUL MACHINES COUNT

How many VMs to reserve.

Note:

You can include up to 100 VMs in a single reservation.

- RESERVATION DATE

The time period that you want the reservation to be active. Can be one of:

- Reserve Now

Use this to calculate the ideal placement for a workload that you want to deploy today.

Turbonomic begins planning the reservation immediately when you click **CREATE RESERVATION**. The reservation stays in effect for 24 hours – At that time Turbonomic deletes the reservation.

- Future Reservation

This executes the reservation for the date range you specify. Turbonomic begins planning the reservation on the day you set for START DATE. The END DATE determines when the reservation is no longer valid. At that time, Turbonomic deletes the reservation.

When you are finished with the reservation settings, click **CREATE RESERVATION**. Turbonomic displays the new reservation in the Workload Placement page. Depending on the reservation settings and your environment, the reservation can be in one of the one of the following states:

- UNFULFILLED

The reservation request is in the queue, waiting for an ongoing reservation request to complete.

- INPROGRESS

Turbonomic is planning the placement of the reservation workloads.

- FUTURE

Turbonomic is waiting for the START DATE before it will start to plan the reservation.

- RESERVED

Turbonomic has planned the reservation, and it found providers for all the VMs in the reservation.

As your environment changes, Turbonomic continues to calculate the placement for the reservation

VMs. If at any time it finds that it cannot place all the VMs, it changes the reservation to PLACEMENT FAILED.

- **PLACEMENT FAILED**

Turbonomic cannot place all the reservation VMs. As your environment changes, Turbonomic continues to calculate placement for the VMs. If at any time it finds that it can place all the VMs, it changes the reservation to RESERVED.

- **INVALID**

An error occurred while planning the placement of the reservation VMs.

Note:

The list of reservations refreshes whenever you open the Workload Placement page. To see changes in reservation state, navigate away from the page, and navigate back to it again.

Managing Reservations

Click the name to open the Reservation Settings fly-out

Expand the list entry for details

Search...		FILTER	
5 Reservations			
<input type="checkbox"/>	Cud_GiantVM Cud_GiantVM 2/7/2020 - 3/7/2020 PLACEMENT_FAILED "GiantVM"	PLACEMENT FAILED	>
<input type="checkbox"/>	CudMultipleVMs 10 "Hatice_VM" placed on HawthorneDev	RESERVED	⌵
Host hp-dl565.eng.vmturbo.com		Storage QSGRID01:NFSShare	
<input type="checkbox"/>	CudRes4	FUTURE	>
<input type="checkbox"/>	CudRes5 1 "Hatice_VM" placed on HawthorneDev	RESERVED	>
<input type="checkbox"/>	MyReservation MyReservation 2/7/2020 - 3/7/2020 RESERVED "Hatice_VM"	RESERVED	>

Click a provider name to drill down to that entity

The PLACE page displays the current list of reservations. You can expand items in the list to see some details, or you can click to view the full details. You can also select items to delete them, which cancels the reservation or deployment.

For an entry in the RESERVED state, you can click the entry name to open the Reservation Settings fly-out.

To delete a reservation, select it in the list and click the DELETE icon.

To see details about the provider entities, or the datacenter that is hosting the reserved VMs, click that entity name.

Deploying Workloads to the Reserved Resources

When you reserve resources, you know that they will be available for you to deploy actual VMs in your environment. To deploy these VMs, you should:

1. Note the placement that your reservation has calculated.

Expand the reservation entry in the Workload Placement page and note the hosts and storage that will provide resources for your VMs.

2. Delete the reservation.

Before you deploy the reserved VMs, you should delete the reservation. This frees up the Turbonomic market to manage the placement of the VMs you are about to deploy.

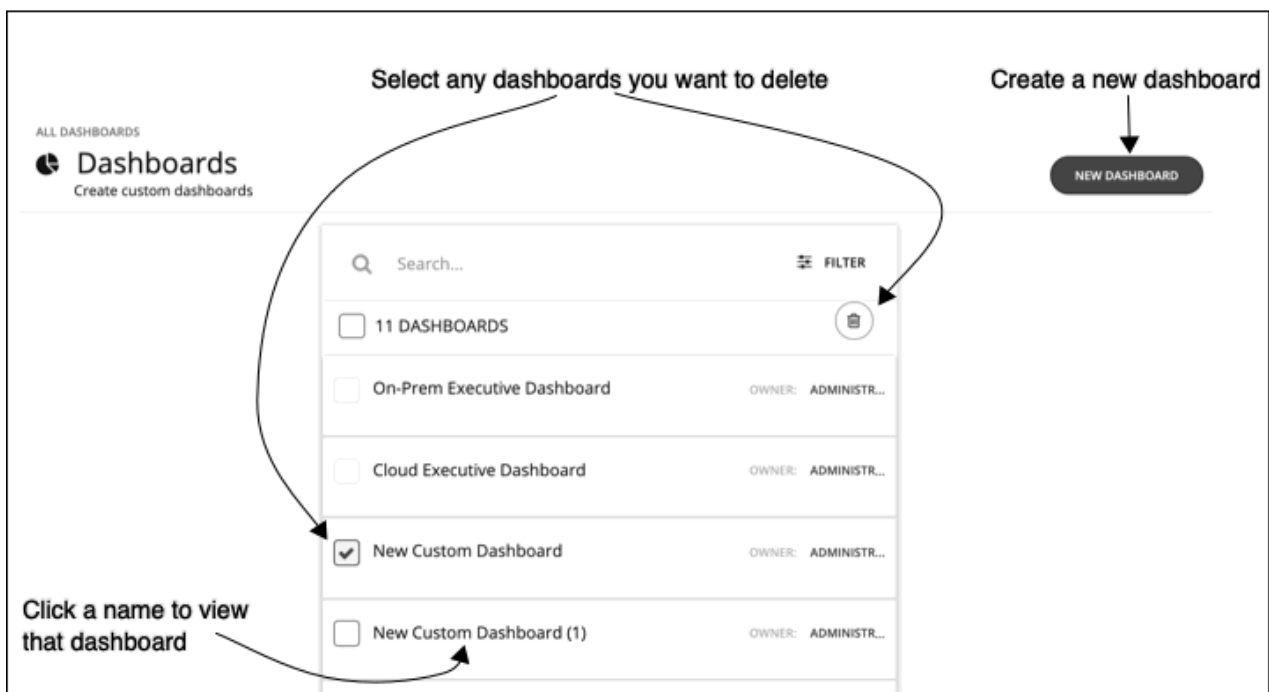
Note:

When you delete a reservation from the user interface or API, Turbonomic only marks the reservation for deletion and waits 48 hours before permanently deleting it. You can permanently delete a reservation by using the API's `reservation_force_delete` parameter along with a DELETE call to a specific reservation. When `reservation_force_delete = true`, the system removes the reservation permanently, no matter what state it is in.

3. Deploy the actual VMs.

In your Hypervisor user interface, deploy the VMs to the hosts and storage that you noted. When you are done, Turbonomic will manage their placement the same as it manages the rest of your environment.

Dashboards: Focused Views



Dashboards give you views of your environment that focus on different aspects of the environment's health. At a glance, you can gain insights into service performance health, workload improvements over time, actions performed and risks avoided, and savings in cost. For cloud environments, you can see utilization of reserved instances, potential savings, required investments, and the cost/performance of specific cloud accounts.

The Dashboards page lists all the dashboards that are available to you, including built-in and custom dashboards that your account can access. To view a dashboard, click its name in the list.

From the Dashboard page, you can also create your own custom dashboards.

Note:

In charts that show tables, if the table contains more than 500 cells, then the User Interface disables the option to export the chart as PDF. You can still export the chart as a CSV file to load in a spreadsheet.

Built-in Dashboards

Built-in Dashboards are scorecards of your environment. They demonstrate how well you are improving performance, cost, and compliance, as well as opportunities for further improvements that are available.

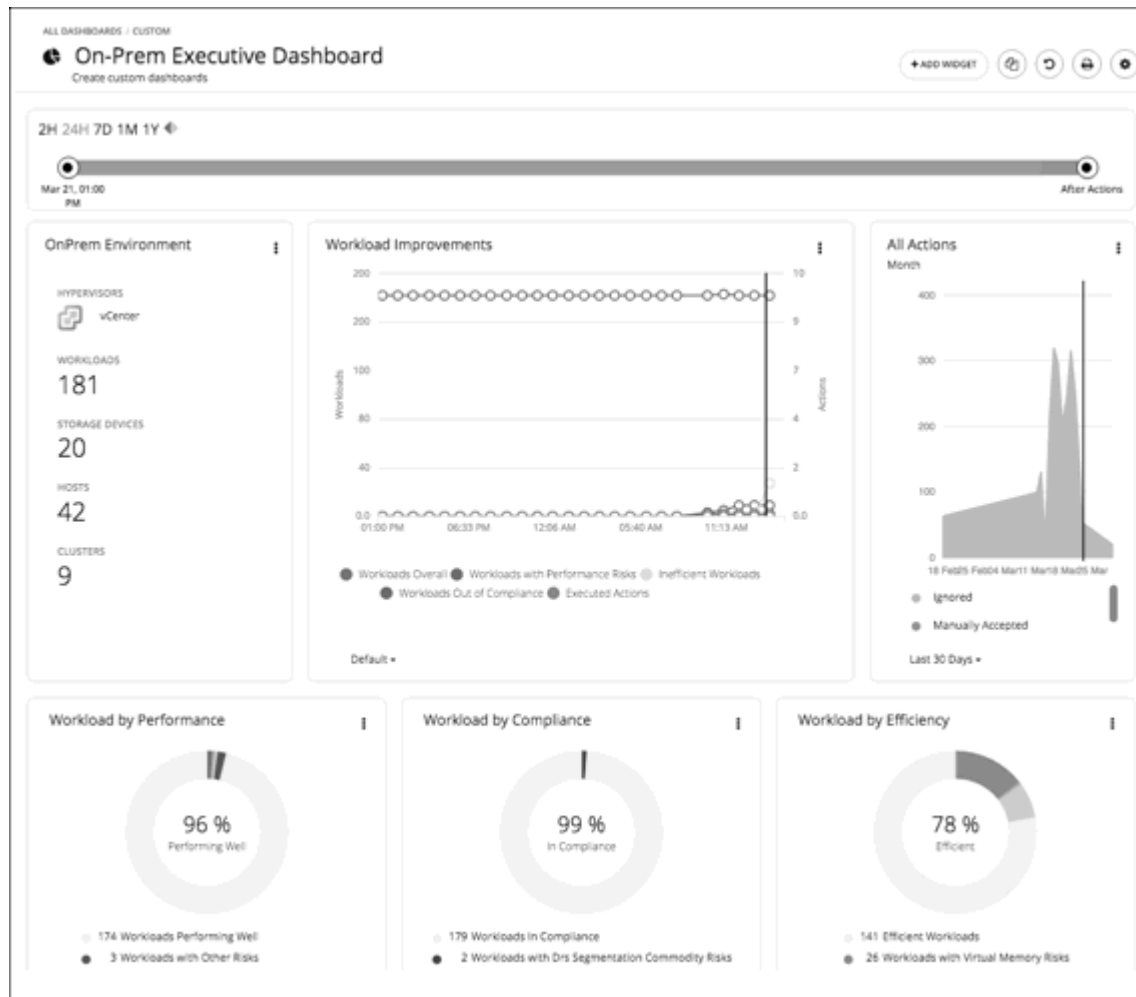
Turbonomic ships with these dashboards:

- On-Prem Executive Dashboard
- Cloud Executive Dashboard
- Container Platform Dashboard

Note:

Turbonomic ships these dashboards with default configurations. To edit a dashboard, you must log in with the administrator user account. Users logged in with that account can add or remove chart widgets, and change widget scopes. For information about editing dashboards, see [Creating and Editing Custom Dashboards](#).

On-Prem Executive Dashboard

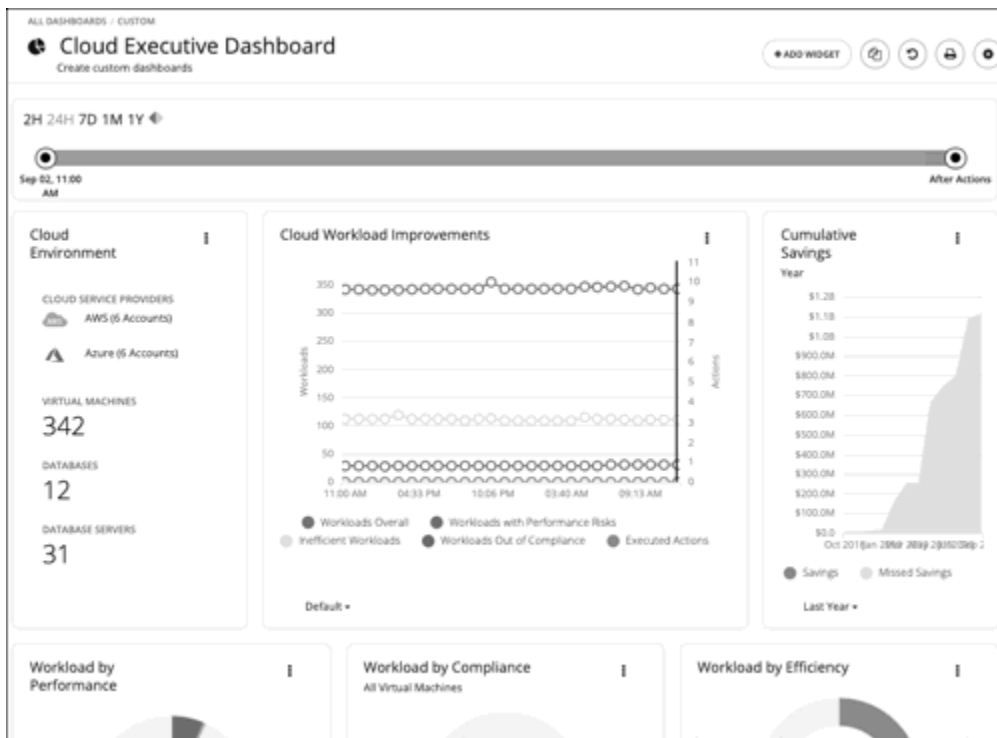


The On-Prem Executive Dashboard shows the overall performance, capacity, and compliance in your on-prem infrastructure. This includes insights into:

- Actions History

- The **On-Prem Environment** chart widget shows you an overview of your on-prem environment that Turbonomic is managing and controlling. The chart displays the workloads and the infrastructure that Turbonomic discovered.
- The **Workload Improvements** chart widget shows how the efficiency, performance, and policy risks associated with your workloads have disappeared as you have increased your adoption of Turbonomic Workload Automation. The chart tracks how your workloads have grown as your execution of actions have increased or decreased as your environment achieves and maintains its desired states over time.
- The **All Actions** chart widget shows the number of actions that Turbonomic has generated versus the ones executed. This gives you an understanding of where there were more opportunities for improvement that were not taken in the past versus those that are available today.
- Opportunities
 - The **Workload by Performance**, **Workload by Compliance**, and **Workload by Efficiency** chart widgets indicate workload health by showing the risks that are currently in your environment and each classification of those risks. You can click **Show Action** on the chart to reveal all of the outstanding actions that need to be taken to resolve those risks on your workloads.
 - The **Necessary Investments** and **Potential Savings** chart widgets together project how the current actions to improve performance, efficiency, and compliance will impact your costs.
- Current State
 - This chart shows the top clusters in your on-prem environment by CPU, memory, and storage capacity or utilization. In the default view, the chart shows the top clusters by CPU headroom (available capacity). It also shows time to exhaustion of cluster resources, which is useful for future planning (for example, you might need to buy more hardware).
 - The **Virtual Machines vs Hosts and Storage -Density** chart widgets show how your overall density has improved in your on-prem environment. A high count of VMs per host or storage means that your workloads are densely packed.

Cloud Executive Dashboard



Note:

For the Version 7 family of Turbonomic, cloud features are Early Access, only. These features appear in the user interface and the documentation, but this version does not enable them for use.

The Cloud Executive Dashboard shows your overall cloud expenditures and how you can improve performance and reduce cost. This includes insights into:

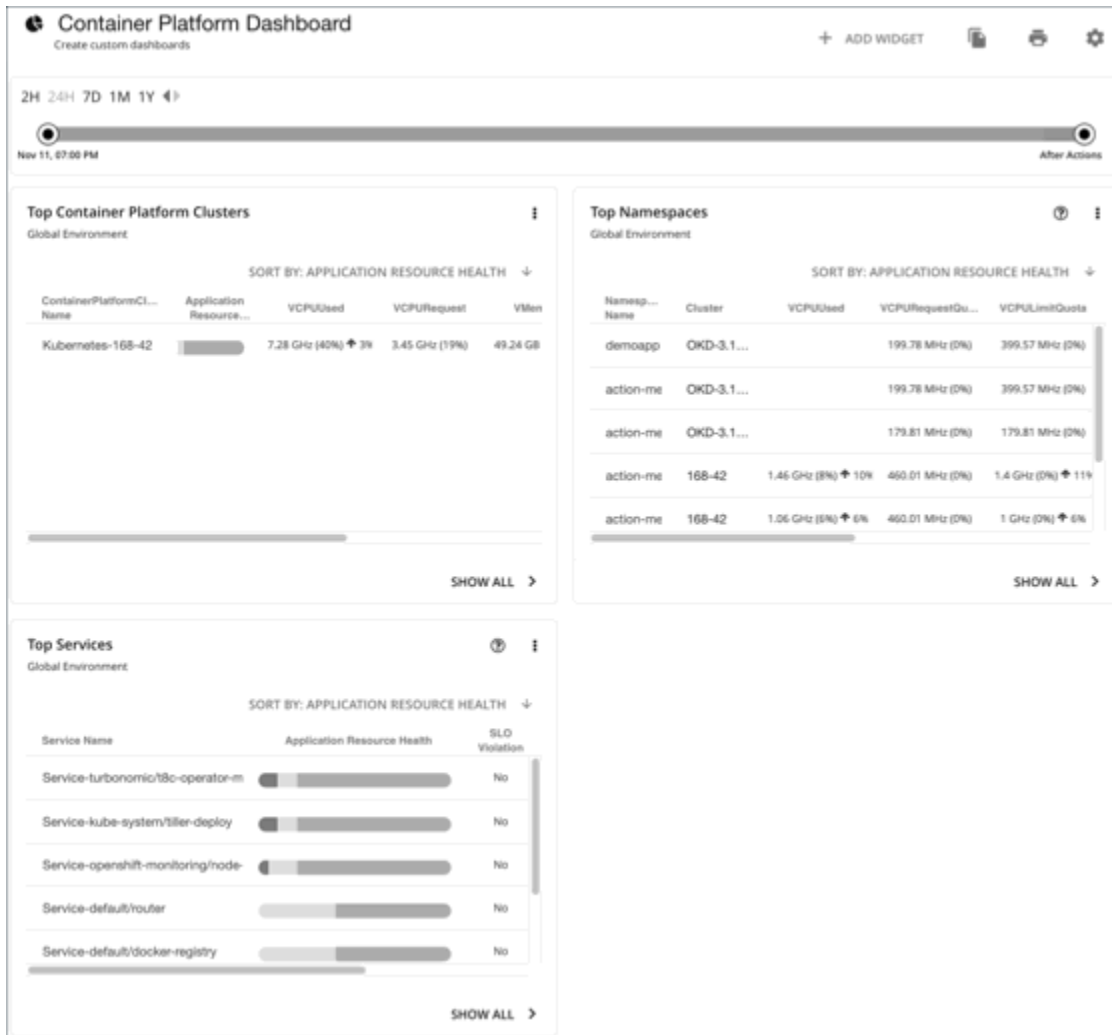
- Actions History
 - The **Cloud Environment** chart widget shows you an overview of your cloud environment that Turbonomic is managing and controlling. The chart displays the workloads, cloud service providers, and cloud accounts that you currently have set up as Turbonomic targets.
 - The **Workload Improvements** chart widget shows how the efficiency, performance, and policy risks associated with your workloads have disappeared as you have increased your adoption of Turbonomic Workload Automation. The chart tracks how your workloads have grown as your execution of actions have increased or decreased as your environment achieves and maintains its desired states over time.
 - The **Cumulative Savings** chart widget shows you the cost savings for executed cloud actions compared to the cloud actions that you have not executed (missed savings).
- Opportunities
 - The **Workload by Performance**, **Workload by Compliance**, and **Workload by Efficiency** chart widgets indicate workload health by showing the risks that are currently in your environment and each classification of those risks. You can click **Show Action** on the chart to reveal all of the outstanding actions that need to be taken to resolve those risks on your workloads.
 - The **Necessary Investments** and **Potential Savings** chart widgets together project how the current actions to improve performance, efficiency, and compliance will impact your costs.
 - **Cloud Estimated Cost** chart widget shows estimated monthly costs and investments for the cloud. Monthly cost amounts are summarized as amounts with and without actions.
- Current State
 - The **Top Accounts** chart widget shows all of the cloud accounts in your cloud environment and what the utilization is for each account. You can see the number of workloads, estimated monthly costs, saved by actions, and actions taken. In the default view, the chart shows the top cloud accounts and you can click **Show All** button to see all of the accounts. In the Show All list, you can also download the account cost data as a CSV file or PDF.
 - The **Cost Breakdown by Tag** chart widget shows the tags you have assigned to your cloud resources and the costs associated with each of these tagged categories. The **Cost Breakdown by Cloud Service Provider** chart widget is an Expenses chart widget that shows your expenses for each cloud service provider.
 - Usage of Reserved Instances

Reserved Instances (RIs) reduce cost by offering a subscription-based payment plan. Turbonomic discovers these RI plans and tracks usage patterns to identify workloads that are good RI candidates. The Cloud Executive Dashboard shows whether you are getting the most out of your current RI strategy.

The **RI Utilization** chart widget shows how well you have utilized the reservation inventory. The chart compares the capacity for all reservations versus the RI consumption by virtual machines.

The **RI Coverage** chart widget compares the capacity of your current VM workload to the capacity of workload that is covered by Reserved Instances.

Container Platform Dashboard



The Container Platform Dashboard shows the overall performance, capacity, and health of your container infrastructure. This includes insights into:

- **Top Container Platform Clusters**
Assess the health of your clusters and sort them by risk level.
- **Top Namespaces**
Identify namespaces that are running out of quota, and how much resources each namespace is using in both quotas and actual utilization.
- **Top Services**
Assess the impact of Services on the performance of your applications.

Creating and Editing Custom Dashboards

A custom dashboard is a view that you create to focus on specific aspects of your environment. You can create dashboards that are private to your user account, or dashboards that are visible to any user who logs into your Turbonomic deployment.

Two common approaches exist for creating custom dashboards:

- **Scope First**
You can create a dashboard in which all of the chart widgets focus on the same scope of your environment. For example, you might want to create a dashboard that focuses on costs for a single

public cloud account. In that case, as you add chart widgets to the dashboard, you give them all the same scope.

- Data First

You might be interested in a single type of data for all groups of entities in your environment. For example, each chart widget in the dashboard can focus on Cost Breakdown by Cloud Service, but you set the scope of each chart widget to a different cloud region or zone.

Of course, you can mix and match, according to your needs. You can set any scopes or data sources to the chart widgets in a dashboard to set up whatever organization and focus that you want.

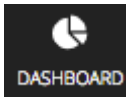
Note:

If you set a scope to your Turbonomic session, the specified scope does not affect your custom dashboards. For information about scoped views, see [Working With a Scoped View](#).

Creating a Dashboard

To create a custom dashboard:

1. Navigate to the Dashboards Page.



Click to navigate to the Dashboard Page.

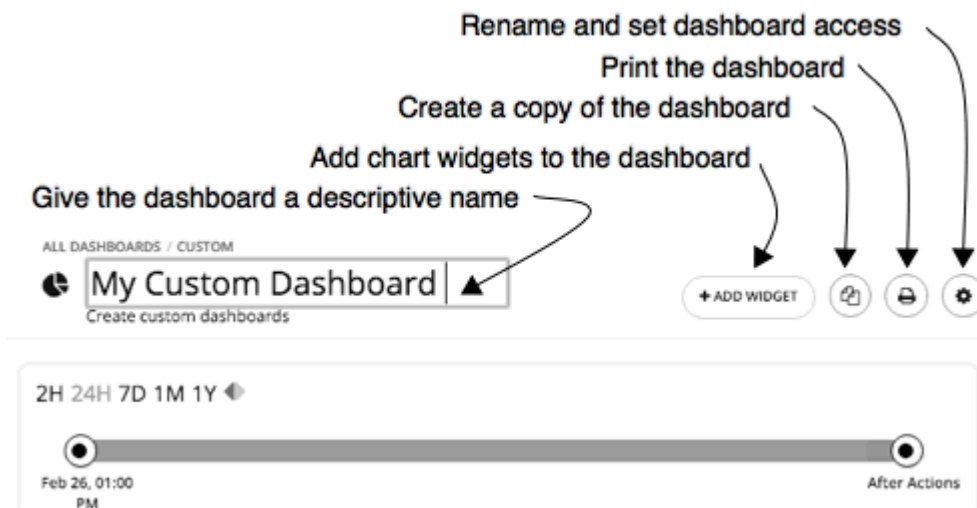
This page lists all dashboards that are available to you.

To view a dashboard, click its name in the list.

2. Create a new dashboard.



Click **NEW DASHBOARD** to add a new dashboard to your Turbonomic session. The dashboard appears with a default name and without chart widgets. The time range in the Time Slider is set to 24 hours by default.



3. Name the dashboard.

Give a name that describes the dashboard. If you will share the dashboard with all Turbonomic users, the name will help them decide whether to view it.

4. Add chart widgets to the dashboard.



Add as many chart widgets to the dashboard as you want. See [Creating and Editing Chart Widgets](#).

5. Optionally, set the dashboard access.

Click **Gear** to change the setting.

Dashboard access can be:

- **Only Me** – The dashboard is only available to your Turbonomic user account.
- **All Users** – Every Turbonomic user can see this dashboard.

By default, access is set to **Only Me**.

As soon as you create a new dashboard, it appears in the list on the Dashboard Page. Users with access to it can click the dashboard name in the list to view it.

At any time, if you are an administrator or the dashboard owner, you can view and make the following changes to the dashboard:

- Add, edit, or delete widgets
- Change the dashboard name
- Change the dashboard access setting

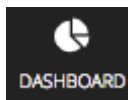
For executive dashboards, only an administrator (username=administrator) can edit an executive dashboard.

Editing a Dashboard

If you have created a dashboard, you can change the name of the dashboard, its access settings, and its chart widgets. To change the chart widgets, see [Creating and Editing Chart Widgets](#).

To edit a dashboard's name or change its access settings:

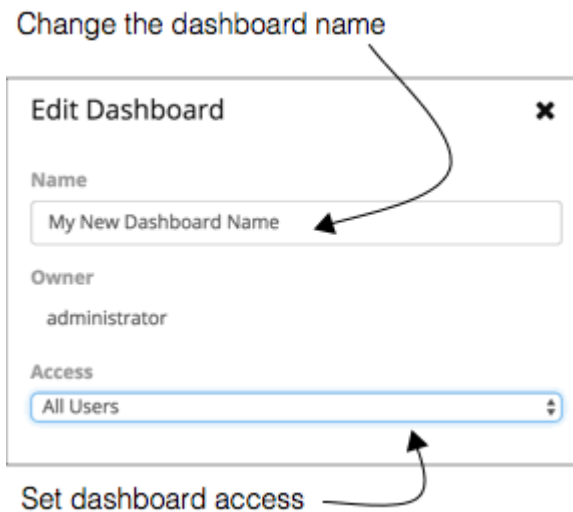
1. Navigate to the Dashboards Page.



Click to navigate to the Dashboard Page.

2. Click the name of the dashboard that you want to edit.
3. Click **Gear** in the dashboard.

In the dashboard's Edit fly-out, make your changes.



For the dashboard's access, you can set:

- **Only Me** – The dashboard is only available to your Turbonomic user account.
- **All Users** – Every Turbonomic user can see this dashboard.

4. When you are done, close the fly-out panel.

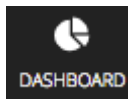
Your changes take effect when you close the fly-out.

Deleting a Dashboard

If you are an administrator or the dashboard owner, you can delete a custom dashboard. You cannot delete executive dashboards.

To delete a custom dashboard:

1. Navigate to the Dashboards Page.



Click to navigate to the Dashboard Page.

This page lists all dashboards that are available to you.

2. Delete one or more dashboards.

In the list, choose the checkbox for each dashboard you want to delete and click **Trash can**.

Creating and Editing Chart Widgets

Turbonomic displays information about your environment in various chart widgets. To focus on the information you need, you can add new chart widgets to scoped views and dashboards, and you can edit existing chart widgets. You can also pull the corners of chart widgets to resize them and change the display order of chart widgets in dashboards.

When you create or edit a chart widget, you can choose a variety of settings. For example, in the Top Utilized chart widget, if you choose Clusters as the Entity Type, you can then choose Utilization as the Data Type and Storage Provisioned as the Commodity.

Creating a Chart Widget

To create a new chart widget:

1. Click **Add Widget** to open the Widget Gallery.

In a scoped view

+ Add Widget

On a dashboard

+ ADD WIDGET

On a dashboard, click **Add Widget** at the top-right corner. In a scoped view, click **Add Widget** on the right above the charts.

2. Choose a chart widget in the Widget Gallery.

The Widget Gallery is a list of thumbnail previews of chart widgets.

You can scroll through the gallery or search it. For example, if you type "Health" in the **Search** field, the results are two chart widgets, Health and Workload Health. You can choose chart widgets from these categories:

- Actions and Impact
- Status and Details
- Cloud
- On-Prem

To see the possible displays of a specific chart widget, use the horizontal scroll bar at the bottom of the thumbnail to scroll through the display choices.

To choose a chart widget to add it to your dashboard, click the thumbnail preview.

The Widget Preview window with the Edit fly-out opens.

3. Configure the settings for your chart widget.

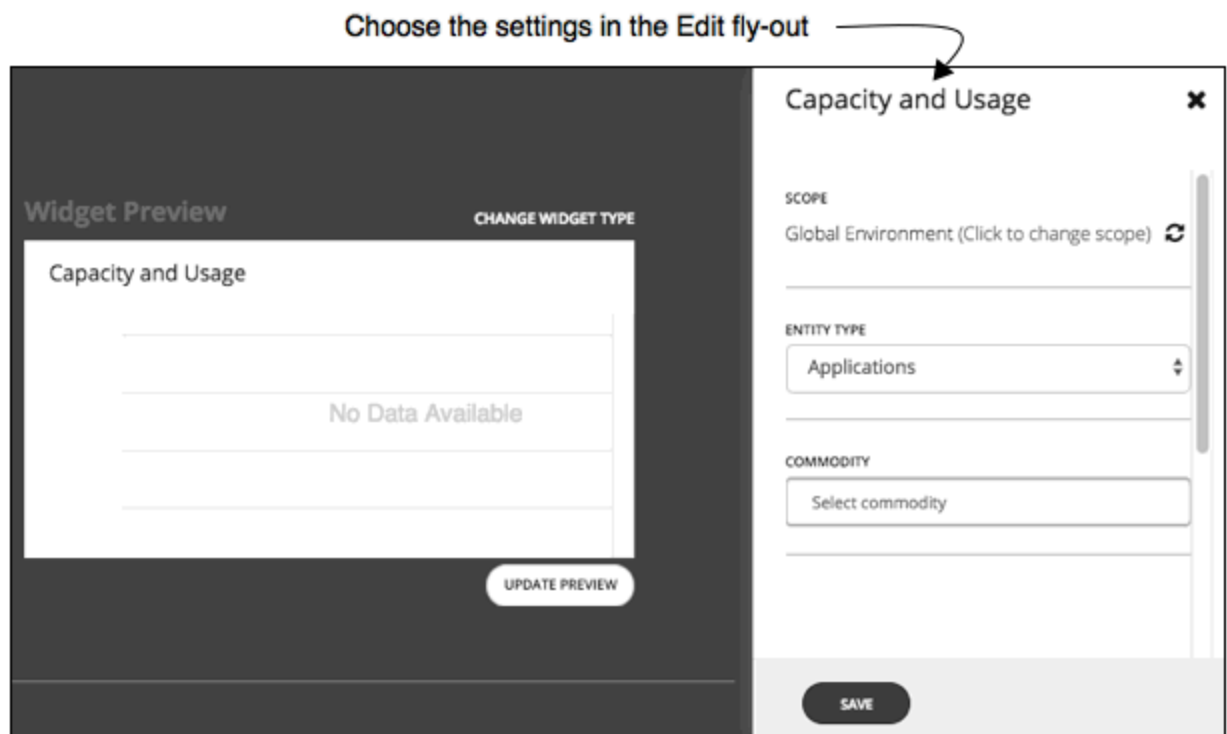
Chart widget settings determine the data that the chart widget will show.

In the Edit fly-out, choose the settings and click **Update Preview** to display the result in the Widget Preview pane.

When you are satisfied with your settings, click **Save**. The chart widget is added to your dashboard.

For information about settings, see [Chart Widget Settings](#).

For example:



To delete a chart widget from your dashboard, choose **Delete** in the More options menu at the top-right corner of the chart widget.

Methods to Access Chart Widget Settings

Two methods exist for accessing the chart widget settings in the Edit fly-out:

- You can access the settings in the Edit fly-out when you add a chart widget to your dashboard after you click a thumbnail preview.
- For an existing chart widget in a dashboard, you can choose **Edit** in the More options menu at the top-right corner.

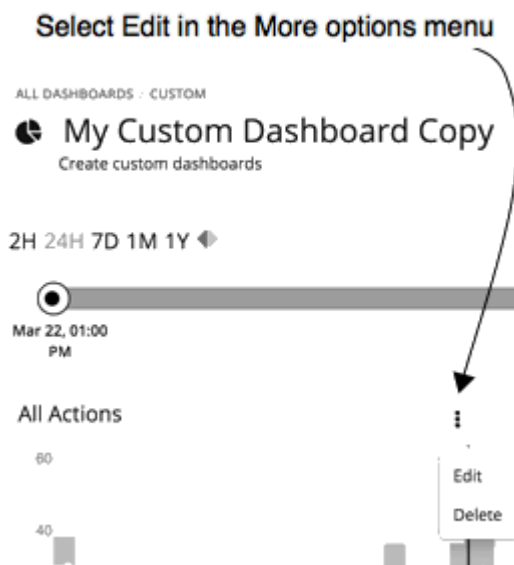


Chart Widget Settings

Chart widget settings vary according to the type of chart widget. Also, depending on the value that you choose for a setting, additional settings may appear. The following is a list of frequently-used chart widget settings:

- Scope

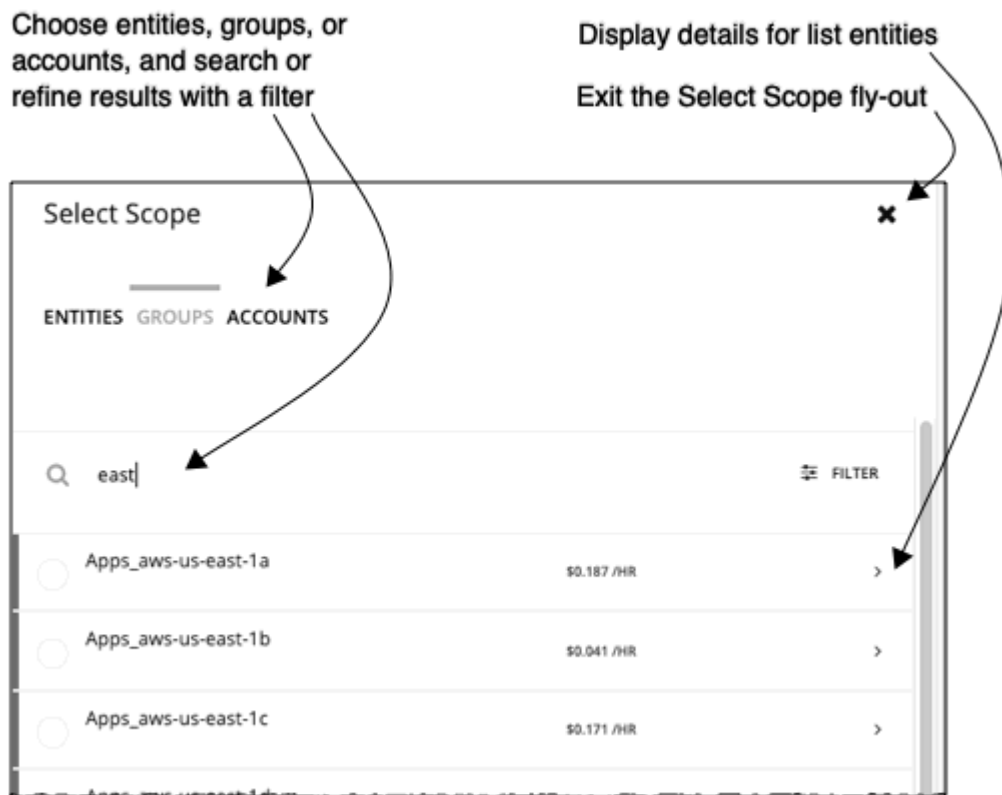
The set of entities in your environment that this chart widget represents. By default, the chart widget scope is set to **Global Environment**.

For every type of chart widget, you have the option to set the chart's scope. To do so:

1. Click **Click to change scope** to open the Select Scope fly-out.
2. In the Select Scope fly-out, choose the entity, group, or account that you want.

The ACCOUNTS tab is available depending on the type of chart widget.

Your choice appears in the **Scope** field.



- Timeframe

The timeframe for historical data or projections in the chart. Choices for the chart's timeframe are: Default, Last 2 Hours, Last 24 Hours, Last 7 Days, Last 30 Days, and Last Year.

If you set the timeframe to **Default**, the dashboard Time Slider controls the timeframe setting. For example, if your dashboard Time Slider is set to one month (1M), then all chart widgets with the Default timeframe in that dashboard are set to one month and show information for one month. Note that the dashboard Time Slider does not override the other specific timeframe settings.

- Chart Type

The chart widget's display type. Most chart widgets can display horizontal bar or ring charts. Other display choices can include tabular data, band chart, stacked bar, line, or area charts.

Note:

For summary charts like horizontal bar and ring charts, when the legend has more than four categories, the remaining categories are represented as a fifth category named "Other."

- **Entity Type**

The type of entities or their data that you want to display in this chart widget. Choices vary (for example, Applications, Hosts, Virtual Data Centers, Storage Devices, and so on).

- **Commodity**

The resources that you want this chart widget to monitor. Some charts can monitor multiple commodities. Choices vary (for example, CPU, Memory, Virtual Storage, and so on).

Chart Types

Turbonomic provides many different types of charts in the Widget Gallery. To design dashboards, you should be familiar with the data each chart presents. These charts provide information on actions, impact, status of your environment, and details about specific entities, cloud, and on-prem environments.

Actions and Impact Chart Types

These chart widgets provide information on actions, pending actions, risks that you avoided, improvements, and potential savings or investments.

Pending Actions Charts

Pending Actions charts show the actions that Turbonomic recommends to improve the current state of your environment.

Chart Type

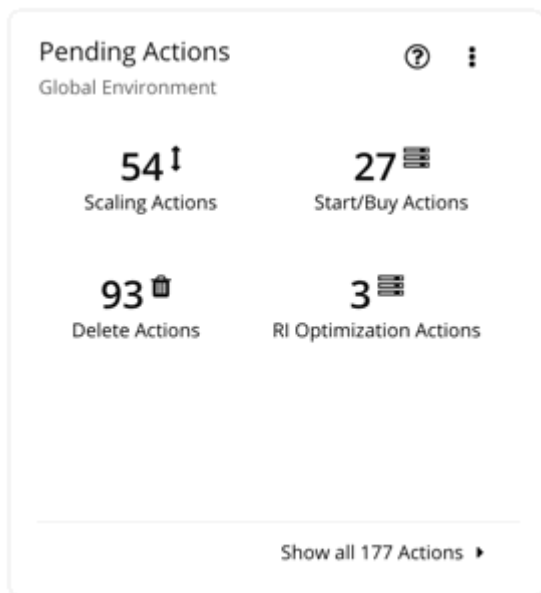
You can set the display to:

- Text
- Ring Chart
- Horizontal Bar
- List

Examples:

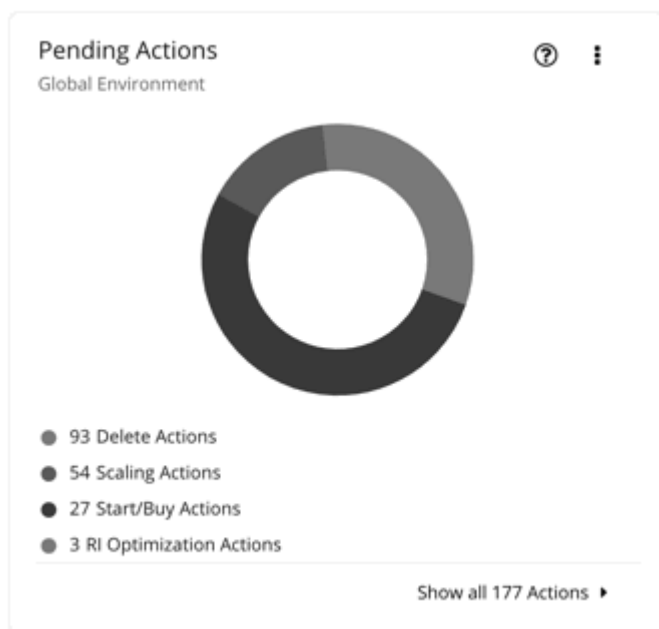
- Text

The text chart shows the number of actions for each action type. It gives a quick visual indication of the kinds of actions that are pending. For details, see [Action Types](#).



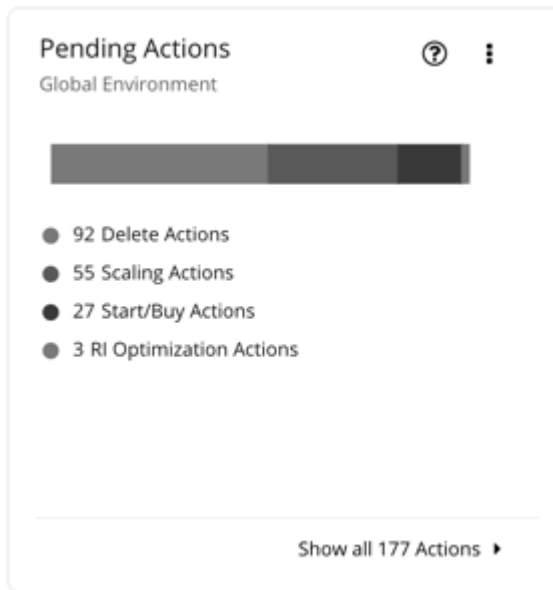
- Ring Chart

The ring chart counts the number of actions for each action type. It gives a quick visual indication of the kinds of actions that are pending. For details, see [Action Types](#).



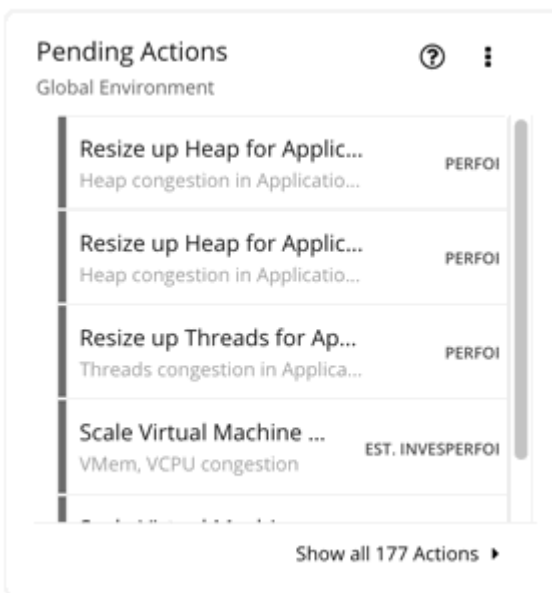
- Horizontal Bar

The horizontal bar chart counts the number of actions for each action type. It gives a quick visual indication of the kinds of actions that are pending. For details, see [Action Types](#)



- List

The list chart shows an abbreviated listing of the actions for the chart's scope. For details about the different actions generated by the product, see [Actions](#).



At the bottom of the chart, click **Show All Actions** to see a full list of pending actions that are in the scope of the chart, along with action details and controls to execute actions. For details, see [Pending Actions List](#).

Actions Charts

Actions charts keep a history of pending (not executed) and executed actions. These charts use historical data from the Turbonomic database. You can set the chart to show hourly, daily, or monthly data points.

Filter

You can filter the chart to show **All Actions** (pending and executed actions) or only **Executed Actions**.

Chart Type

You can set the display to:

- Tabular
- Area Chart
- Text
- Stacked Bar Chart

Stacked Bar Chart



For the Stacked Bar Chart, each bar represents a time period. Hover over the bar to see the number of *unique* actions for that time period. In the default view, the bars represent actions per hour in the last 24 hours. The 2:00 PM bar, for example, shows actions between 2:00 PM and 2:59 PM.

A pending action that remains valid for an extended period of time is counted *once* for each hour, day, and month it remains pending. This also applies to pending actions that go away as conditions in the market change, but are generated again in the future. Once a pending action is executed, it is counted once (this time, as an executed action) on the hour, day, and month of execution.

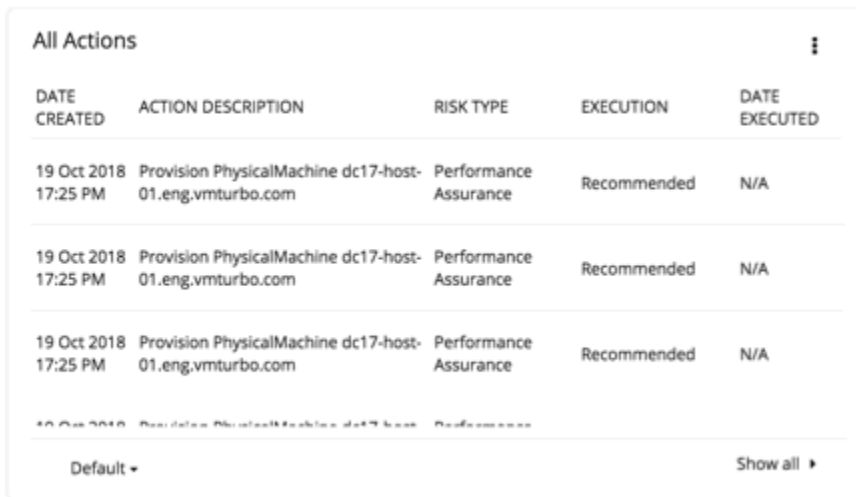
Consider the following scenarios.

- An action was generated at 1:25 PM and then executed two hours later at 3:25 PM.
 - For per-hour views (Last 24 Hours or Default), the action will be counted three times – as a *pending* action in the 1:00 PM and 2:00 PM bars, and as an *executed* action in the 3:00 PM bar.
 - For per-day (Last 7 or 30 Days) or per-month (Last Year) views, the action will be counted once (as an executed action) on the day or month of execution.
- An action was generated at 6:20 PM but went away (without being executed) in the next hour. The same action was generated again the next day at 9:10 AM and was executed immediately.
 - For per-hour views, the action will be counted twice – as a pending action in the 6:00 PM bar and as an executed action in next day's 9:00 AM bar.
 - For per-day views, the action will also be counted twice – as a pending action on Day 1 and an executed action on Day 2.
 - For per-month views, the action will be counted once (as an executed action) on the month of execution.

Use the chart to evaluate the rate of action execution, which underscores the importance of executing actions in a timely manner. As pending actions persist, they become more challenging to track and your environment stays in a risky state longer. To reduce potential delays in executing actions, consider action automation.

Tabular Chart

To see the [full list](#) of actions, click **Show All** at the bottom of the chart.



DATE CREATED	ACTION DESCRIPTION	RISK TYPE	EXECUTION	DATE EXECUTED
19 Oct 2018 17:25 PM	Provision PhysicalMachine dc17-host-01.eng.vmturbo.com	Performance Assurance	Recommended	N/A
19 Oct 2018 17:25 PM	Provision PhysicalMachine dc17-host-01.eng.vmturbo.com	Performance Assurance	Recommended	N/A
19 Oct 2018 17:25 PM	Provision PhysicalMachine dc17-host-01.eng.vmturbo.com	Performance Assurance	Recommended	N/A
19 Oct 2018 17:25 PM	Provision PhysicalMachine dc17-host-01.eng.vmturbo.com	Performance Assurance	Recommended	N/A

Default ▾ Show all ▶

Risks Avoided Charts

As you execute the actions Turbonomic has recommended, you improve your environment's health and avoid risks to performance or cost. These charts show how many risks you have avoided over time. For example, the charts can show how many over-provisioning and congestion risks you avoided.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Optimized Improvements Charts

Turbonomic automatically executes or recommends actions, depending on the policies that you set up. For the recommended actions, you can use Optimized Improvements charts to show how utilization of resources would change assuming you accept all of the [pending actions](#).

Entity Type

Entity types you can choose include:

- Business Applications
- Business Transactions
- Services
- Application Components
- Chassis
- Containers
- Container Pods
- Container Specs
- Namespaces
- Workload Controllers
- Data Centers

- Databases
- Database Servers
- Disk Arrays
- IO Modules
- Internet
- Logical Pool
- Networks
- Hosts
- Regions
- Storage Devices
- Storage Controllers
- Switches
- Virtual Data Centers
- Virtual Machines
- Volumes
- Zones

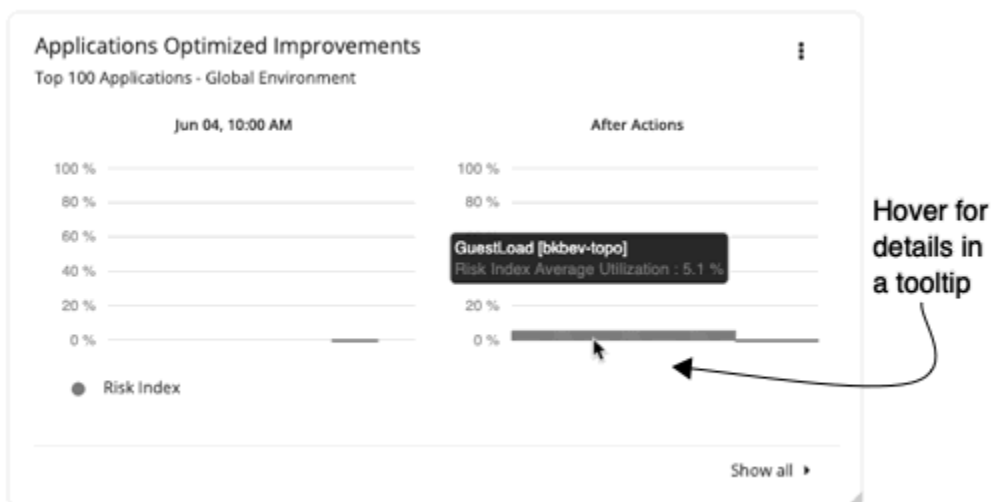
Commodity

Depending on the entity type, you can add different resource commodities that you want to measure. For a chart of Hosts, you can measure commodities such as CPU, Memory, and even network flow between VMs that are on the same host (In-Provider Flow) or on other hosts (In-DPOD or Cross-DPOD Flow).

Display

Optimized Improvements charts show two bar charts for the entities that are in scope – one for current consumption, and the other for the consumption you would expect to see if you execute all the actions.

Example: An Optimized Improvements chart for applications



Potential Savings or Investments Charts

These charts show potential savings or necessary investments in your cloud expenditure, assuming you execute all the pending actions that Turbonomic identifies as a result of its analysis.

For example, if some workloads risk losing performance, Turbonomic might recommend scaling actions for the virtual machine to increase resources. The Necessary Investments chart shows how these actions translate to an increase in expenditure.

On the other hand, if there are pending actions to scale a virtual machine, which result in reduced monthly costs, the Potential Savings chart shows the reduced cost that would result from those actions.

This chart also track RI optimization actions. Virtual machine scaling actions may result in a freed up RI, which can now be applied to a different virtual machine. RI optimization actions reflect the potential savings resulting from reassigning the RI to a different virtual machine. These actions are not executed by Turbonomic users. They reflect RI reassignment, which the cloud provider will take care of.

The projected amounts include on-demand costs for VMs. For information about on-demand cost calculations, see [Estimated On-demand Monthly Costs for Cloud VMs](#).

Type

You can choose **Potential Savings** or **Necessary Investments**.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

For the ring chart, you can click an action type (for example, **Scale Volumes**) in the chart or legend to display a filtered view of the actions list.

Show All

Click **Show all** at the bottom of the chart to see a breakdown of savings or investments by action/entity type and entity. By default, the actions are shown in order of largest amounts so you can easily identify which ones will incur the highest costs or introduce the most savings.

For example, you can see the savings you would realize if you execute all *Scale* actions on the *virtual machines* included in the chart's scope.



The table then breaks down the total savings by individual virtual machines, and includes links to the specific actions that you need to perform to realize those savings.

Potential Savings									
SCALE	Scale Actions 92 Savings \$3,715/mo								
Virtual Machines (92)	<input type="checkbox"/>	Virtual Machine Name	Account	Instance Type	RI Cover...	On-Demand Cost	New Instance Type	New RI Coverage	New On-Dem...
Database Servers (3)	<input type="checkbox"/>	i-09b3a3ebd5f1d7...	Dev	t2.xlarge	0%	\$0.371/hr	m5.2xlarge	100%	\$0/hr
BUY	<input type="checkbox"/>	eks-cluster-eks-w...	Advanced	t2.xlarge	0%	\$0.371/hr	m5.2xlarge	100%	\$0/hr

You can also compare instance types, costs, and RI coverage before and after executing the actions, allowing you to easily identify actions with the most savings.

Status and Details Chart Types

These chart widgets provide information on the status of your environment and details about specific entities.

Health Charts

Health charts show the current status of your environment, by entity type. For example, you can choose to show the health of all hosts in your environment, or the health of all the workloads running on a public cloud region.

Entity Type

Entity types you can choose include:

- Business Applications
- Business Transactions
- Services
- Application Components
- Chassis
- Containers
- Container Pods
- Container Specs
- Namespaces
- Workload Controllers
- Data Centers
- Databases
- Database Servers
- Disk Arrays
- IO Modules
- Internet
- Logical Pool
- Networks
- Hosts
- Regions
- Storage Devices
- Storage Controllers
- Switches
- Virtual Data Centers
- Virtual Machines
- Volumes
- Zones

Chart Type

You can set the display to:

- Text

- Ring Chart
- Horizontal Bar

Basic Info Charts

The Basic Info charts provide an overview of a single entity or individual Azure resource group that you have chosen as your scope.

Type

You can choose:

- **Entity Information**

This chart shows basic information (ID, Name, Type, State, Severity, Target Name, and so on) for the scoped entity or Azure resource group.

- **Related Tag Information**

This chart lists any available tag information for the scoped entity or Azure resource group. For example, in a cloud environment, if a virtual machine has tags applied to it, the chart shows those tags for the virtual machine.

Display

The chart shows the information as Tabular.

Capacity and Usage Charts

These charts list the resources for the selected entity type, showing their allocated capacity and how much of that capacity is in use.

Entity Type

Entity types you can choose include:

- Business Applications
- Business Transactions
- Services
- Application Components
- Containers
- Container Pods
- Container Specs
- Namespaces
- Workload Controllers
- Data Centers
- Database Servers
- Disk Arrays
- Logical Pool
- Networks
- Hosts
- Regions
- Zones
- Storage Devices
- Storage Controllers

- Virtual Machines
- Volumes

Commodity

Depending on the entity type, you can add different resource commodities that you want to measure. For example, for a chart of Virtual Machines, you can measure commodities such as virtual CPU, memory, and storage.

Note:

For a cloud database server, the chart might show incorrect *used* values for vMem and Storage Amount after an action executes. It could take up to 40 minutes for the correct values to display.

Display

The chart shows the information as Tabular.

Multiple Resources Charts

Multiple Resources charts show the historical utilization of commodities for the scoped entity or a group of entities. The vertical bar shows the current moment – plots that extend to the right project utilization into the future.

Entity Type

Entity types you can choose include:

- Business Applications
- Business Transactions
- Services
- Application Components
- Containers
- Container Pods
- Container Specs
- Namespaces
- Workload Controllers
- Data Centers
- Database Servers
- Disk Arrays
- Logical Pool
- Networks
- Hosts
- Regions
- Zones
- Storage Devices
- Storage Controllers
- Virtual Machines
- Volumes

Commodity

Depending on the entity type, you can add different resource commodities that you want to measure. For example, for a chart of volumes, you can measure commodities such as IO throughput, storage access, and storage amount.

Show Peaks

Edit the chart and choose the **Show Peaks** checkbox to include peak information in the chart.

Display

The chart shows the historical utilization and, if chosen, the peak information as a Line chart.

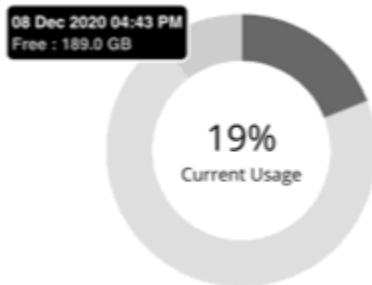
Resources Charts

Resources charts show the utilization of a resource over time, for the entities in the chart's scope. The chart title shows the resource that you are plotting, as well as the chart's current scope.

To see finer details about your environment, you can set up charts that show utilization of specific commodities. For example, you can set up a dashboard with a number of Resources charts with their scopes set to the same cluster. Such a dashboard gives you a detailed look at the health of that cluster. Or you could make a dashboard with each chart scoped to a different cluster, but have all the charts show the same resource utilization.

Ring Chart

For certain entity types (such as hosts, storage, and disk arrays), you will see a ring chart on the left that indicates the current overall utilization of a particular resource. Hover over the ring chart to see the following information:



- Free: Available capacity
- Used: Utilized capacity
- Reserved: Unavailable capacity due to utilization constraints

The sum of *Free* and *Used* capacity equals the total allocated capacity.

In addition to showing the currently discovered free and used capacity, Turbonomic also calculates *Reserved* capacity based on utilization constraints set in policies.

For example, for a cluster with 100 GB of allocated storage, Turbonomic might discover 80 GB of free capacity, and 20 GB of used capacity. If the cluster is currently applying a storage policy that has a utilization constraint of 90%, then Turbonomic will show 10 GB of reserved capacity.

Commodity

You can set a Resources chart to one of the following resources:

- Ballooning

Percentage of the host's ballooning capacity that is in use.

- CPU / CPU Allocation / CPU Provisioned

Percentage of CPU cycles that are devoted to processing instructions.

- Connection

The connections in use, as a percentage of the maximum connections allowed on the database. Database configuration determines the capacity for this resource.

- DBCacheHitRate

Percentage utilization of the database server's allocated cache hit rate, where a greater value indicates fewer disk reads for data.

- DBMem

The memory in use by the database, as a percentage of the allocated capacity. Database configuration determines the capacity for this resource. Note that for databases, Turbonomic uses this resource to drive actions, instead of the VMem on the hosting VM. This means that actions are driven by the actual memory consumption on the database.

- Disk Array Access

- Host LUN Access

- Heap

The heap capacity allocated for an application. Charts show the percentage of capacity that is used by an Application Component.

- IO Throughput

Data rate through the host's IO adapter, measured in KBytes/sec.

- Memory / Memory Allocation / Memory Provisioned

Host memory, measured in Kbytes.

- Number of Disks

- Number of Replicas

For details, see [Number of Replicas chart](#).

- Net Throughput

Data rate through the host's Network adapter, measured in Kbytes/sec.

- Port Channel

- Q16 / Q1 / Q2 / Q32 / Q4 / Q64 / Q8 VCPU

- Remaining GC Capacity

Percentage of CPU time *not* spent on garbage collection (GC).

- Response Time

Percentage utilization of a resource's allocated response time.

- SLA Commodity

- Storage Access

Storage access operations per second.

- Storage Allocation

- Storage Amount

- Storage Latency

Percentage of allocated latency that is in use on the storage.

- Storage Provisioned

How much the given storage is over-subscribed. Storage Provisioned capacity is the storage capacity multiplied by the Storage Overprovisioned Percentage (200 by default). The higher this value, the greater the risk that storage is over-committed.

- **Swapping**
The rate of memory swapping to disk, in bytes per second.
- **Tenancy Access**
- **Threads**
Percentage of thread capacity that is consumed by an Application Component.
- **Transaction**
Percentage of an application's allocated transaction capacity that is in use.
- **TransactionLog**
The disk space devoted to transaction logging for a database.
- **Virtual CPU**
The allocated CPU capacity, measured in MHz.
- **Virtual Memory**
The allocated memory capacity, measured in Kbytes.

Note that percentages of allocated VMem are measured against the VMem limit (if set) or the allocated VMem capacity, whichever is less. This is also true in reports and recommended actions. For example, assume a VM with allocated VMem of 8 GB, but a limit of 4 GB. In this case, the percentage in a chart shows the percentage utilized of 4 GB.
- **Virtual Storage**
The allocated virtual storage capacity, measured in Kbytes.

Options

Choose **Show Utilization** to see averages and peaks/lows, or **Show Capacity** to see averages and peaks/lows versus capacity.

The **Show Summary** option adds a ring chart to the view, showing the current utilization of the selected commodity.

Chart Type

You can set the following types of display:

- **Line Chart**
A line plot showing resource utilization over time. The vertical green bar shows the current moment – Plots that extend to the right project utilization into the future.
- **Band Chart**
Lines plot average capacity and average used. The chart shows a band where its thickness indicates peaks and lows.

Number of Replicas Chart

This chart shows the replicas of Application Components running over a given time period.

Use this chart if:

- SLO-driven scaling is enabled for a Service, and *provision* or *suspend* actions are executed by Turbonomic. These actions adjust the number of replicas to help you meet your SLO goals.

Or

- Kubernetes [Horizontal Pod Autoscaler](#) (HPA) is enabled for a *Deployment*, *ReplicaSet*, or *StatefulSet* that is exposed as a Service. Turbonomic discovers adjustments to the number of replicas made by HPA.

The chart shows following information:

- **Capacity** values

The number of desired pod replicas configured in the Workload Controller that backs the Service. This can be configured in *Deployment*, *ReplicaSet*, *StatefulSet*, *ReplicationController* or *DeploymentConfig*.

The chart plots the *maximum* observed capacity within the given time period.

- **Used** values

The number of *ready* pods owned by the Workload Controller. Pods in other states (for example, pending pods) are not counted.

The chart plots the *average* used values within the given time period. Hover over the chart to see the minimum and maximum used values.

Top Utilized Charts

Top Utilized charts show the entities or groups with the most utilization.

Entity Type

Entity types you can choose include:

- [Accounts](#) (public cloud)
- Business Applications
- Business Transactions
- Services
- Application Components
- Zones
- Chassis
- [Clusters](#) (of hosts)
- Containers
- Container Pods
- Container Specs
- Namespaces
- Workload Controllers
- Data Centers
- Databases
- Database Servers
- Disk Arrays
- IO Modules
- Internet
- Logical Pool
- Networks
- Hosts
- [Resource Groups](#)
- Regions
- Storage Devices
- Storage Controllers
- Switches
- Virtual Data Centers
- Virtual Machines

- Volumes
- Wasted Files

Data Type

Depending on the entity type (for example, Clusters), you can choose **Headroom** or **Utilization** information in the chart.

Commodity

Depending on the entity type, you can add one or more different resource commodities that you want to measure.

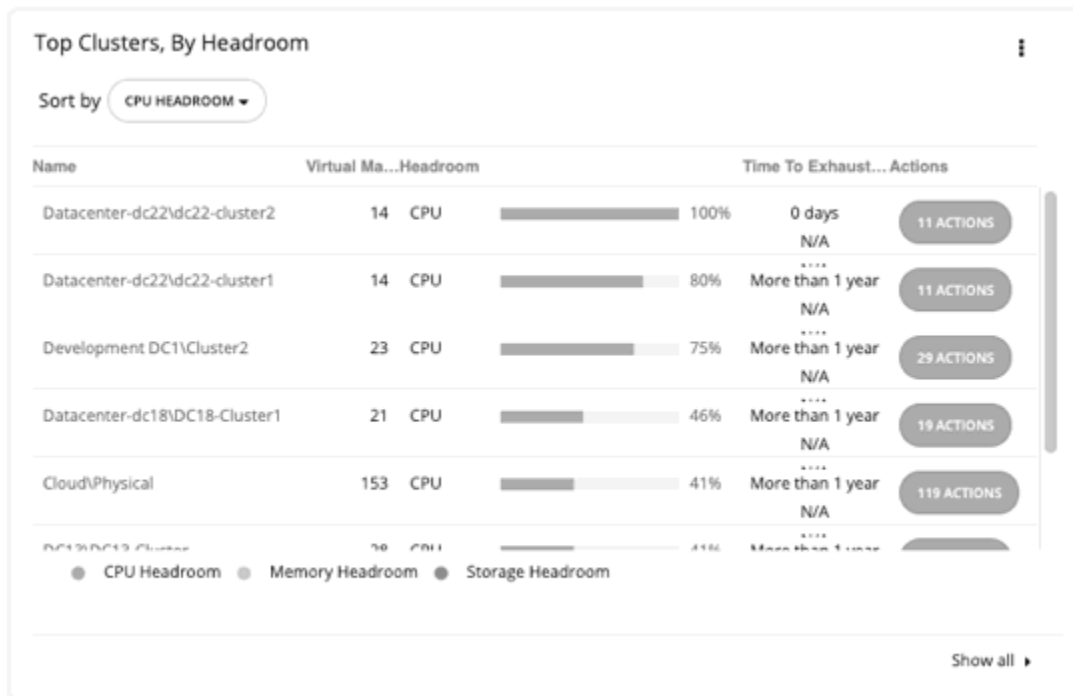
Display

The chart lists the top entities by utilization of the commodities that you or the system has set. Depending on the entity type and scope, you can sort the information. To view the utilization details, hover over the entity to display the tooltip. For cloud entities, the estimated cost for those entities also display.

To drill down to an entity, click the entity name in the chart. This sets the scope to that entity.

Click the **ACTIONS** button for an entity to examine the actions that are pending for it, and then decide which ones are safe to execute.

Example: A top clusters chart which can be sorted by CPU headroom or CPU exhaustion.



Top Clusters Chart

This chart shows the top clusters in your on-prem environment by CPU, memory, and storage capacity or utilization. In the default view, the chart shows the top clusters by CPU headroom (available capacity). It also shows time to exhaustion of cluster resources, which is useful for future planning (for example, you might need to buy more hardware).

To calculate cluster capacity and headroom, Turbonomic runs nightly plans that take into account the conditions in your current environment. The plans use the Economic Scheduling Engine to identify the optimal workload distribution for your clusters. This can include moving your current VMs to other hosts

within the given cluster, if such moves would result in a more desirable workload distribution. The result of the plan is a calculation of how many more VMs the cluster can support.

Click the **ACTIONS** button for a given cluster to see the actions that Turbonomic recommends to keep cluster resources in the desired state, and then decide which ones are safe to execute.

Click **Show All** to see all of the clusters. In the Show All list, you can also download capacity data as a CSV file. Click a cluster name to set the scope to that cluster and view more details about its current capacity and health.

Top Accounts Chart

This chart lists the cloud accounts with the most pending actions. For each account, it shows the cost for all services in the last 30 days. Services include compute, storage, IP, database, reservations, and data transfer. It also shows the savings you would realize if you execute the pending actions. Click the **ACTIONS** button to examine these actions and decide which ones are safe to execute. You can also click an account name to set the scope to that account.

Click **Show all** to view additional information, including the total monthly cost for all accounts, and the number of actions that have been executed for individual accounts or workloads, along with the resulting savings. If you have multiple cloud providers, each provider will have its own tab. You can download the accounts list as a CSV file.

AWS Accounts

The chart shows the AWS master and member accounts that you have added as targets. Accounts with a star symbol are master accounts.

For [AWS GovCloud](#), the 30-day cost is shown as **N/A** since invoicing for these accounts is managed through an associated AWS *standard account*. Adding a standard account as a target is optional. When added, it appears in the Top Accounts chart and shows the total 30-day cost for the GovCloud accounts and the standard account itself.

Note:

Specific RIs can provide savings for multiple accounts. However, individual accounts show the full RI savings, which can result in exaggerated savings for that account.

Azure Accounts

The chart shows the subscriptions discovered via the service principal and EA accounts that you have added as targets, including [Azure Government](#) subscriptions.

GCP Accounts

The chart shows the folders and projects discovered via the GCP service accounts that you have added as targets.

If a service account has access to a folder with projects and subfolders, the folder displays as the top-level account. Click **Show All** to see the full resource hierarchy and top-down data. If a service account has access to a project or subfolder but not its parent folder, the project or subfolder displays as the top-level account.

Top Resource Groups Chart

This chart highlights the estimated monthly cost for the top resource groups in your cloud environment and the savings you would realize if you execute the pending actions. Click the **ACTIONS** button to examine these actions and decide which ones are safe to execute. Click a resource group to set the scope to that group.

The chart also counts actions that have been executed for individual groups, and then shows the resulting savings.

Workload Health Charts

Workload Health charts show the health of workloads from the compliance, efficiency improvement, and performance assurance perspectives. These charts use current (real-time) data for the workloads chosen for the chart widget scope.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Breakdown

You can choose:

- **Workload by Compliance**

A virtual environment can include policies that limit availability of resources. It's possible that the environment configuration violates these defined policies. In such cases, Turbonomic identifies the violation and recommends actions that bring the entity back into compliance.

- **Workload by Efficiency Improvement**

Efficient utilization of resources is an important part of running in the desired state. Running efficiently maximizes your investment and reduces cost. When Turbonomic discovers underutilized workloads, it recommends actions to optimize operations and save money.

- **Workload by Performance Assurance**

Ultimately, the reason to manage workloads in your environment is to assure performance and meet QoS goals. When Turbonomic detects conditions that directly put QoS at risk, it recommends associated actions to assure performance. You can consider these critical conditions, and you should execute the recommended actions as soon as possible.

Workload Health charts indicate actions that you should consider to improve the health of workloads. To see a list of actions, click **Show Actions** at the bottom of the chart.

Environment Charts

Environment charts provide an overview of your environment. They show the targets that you are managing and count the entities that Turbonomic has discovered through those targets. For example, you can display the cloud service providers, hypervisors, and the number of workloads.

Environment Type

You can choose one of the following views:

- Hybrid (both on-prem and cloud)
- Cloud
- On-Prem

Display

The chart shows the information as a Text chart type.

Workload Improvements Charts

Workload Improvements charts track the health of workloads in your environment over time, and map the health to the number of actions Turbonomic has executed in that time period.

In the chart, you can see the significance and value of executed actions:

- Workloads Overall

This is the total number of workloads over time.

- Workloads with Performance Risks

These are the workloads that are not performing well.

- Inefficient Workloads

These are the workloads that are running on under-utilized hosts or are not being utilized.

- Workloads Out of Compliance

These are the workloads that are violating a placement policy. Workloads that are not in compliance might be running on a host or placed on storage, for example, that violate a placement policy.

- Executed actions

Actions that Turbonomic executed.

The vertical line shows when the last data point was polled in your environment.

Environment Type

You can choose one of the following views:

- Hybrid (both on-prem and cloud)
- Cloud
- On-Prem

Display

The chart shows the information as a Line chart.

Cloud Chart Types

These chart widgets provide information on the status of your cloud environment.

For many cloud chart widgets that display costs and savings, Turbonomic uses the billing reports from your cloud service providers to build a picture of your overall costs. The data includes all costs that the service provider includes in the billing report. Turbonomic parses these reports into the formats that it uses for the cloud chart widgets.

Note:

In order for Turbonomic to access AWS monthly reports, you must have created a Cost and Usage report in your AWS account and you must store it in an S3 bucket.

[Displaying AWS Spend In Turbonomic.](#)

Billing Breakdown Charts

Billing Breakdown charts show your expenditure on cloud services, so you can track overall cost, cost by region, or cost by cloud accounts. Turbonomic discovers pricing for cloud services through the cloud accounts and Azure subscriptions that you configured as targets.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Expenses Charts

To help you manage costs for your public cloud environment, IBM tracks compute, storage, license, and IP costs for the workloads in your environment. Are you spending too much on your cloud resources? You can see how your expenses evolve and keep track of these costs over time.

IBM uses the cost for services and workload expenses to track your cloud spend. See [Tracking Cloud Cost](#) for more information about service cost data, compute, storage, license, and IP costs.

Commodity

You can choose:

- **Expenses**

See your hourly expenses over time, as well as overall monthly and yearly costs.

- **Average Expenses**

See your average cost per Virtual Machine, as well as overall monthly and yearly costs.

- **Billed Cost by Service Provider**

See costs over time for each cloud service provider that you use in your cloud environment. For example, you can compare the costs you incur on AWS to costs on Azure.

You can open more than one account from a single service provider. If you are running workloads on different service providers, then this chart shows the distribution of costs across them.

- **Billed Cost by Account**

See costs over time for each account that you have set up as a target in Turbonomic.

Each public cloud target that you configure for Turbonomic represents a public cloud account. You can choose one or more specific accounts depending on your configured public cloud targets. This chart gives you a quick read out of your costs. You can see whether one account shows unusually high cost, or perhaps an account is hardly used at all and you can consider closing it down.

- **Billed Cost by Service**

This chart shows costs over time for each cloud provider service that you use in your cloud environment. For example, you can see costs for your Amazon EC2 instance or AWS Cost Explorer.

To evaluate your use of different services, you can follow your expenditure for each one. Note that for AWS clouds the service names begin with "Amazon" or "AWS". Other services show the names as they are presented in the service provider's billing report. You can also set the scope of this chart to an Azure Resource Group or a group of Resource Groups.

- **Workload Cost Breakdown**

This chart shows costs over time for each component of your cloud utilization. The vertical line indicates when the last data point was polled from your environment. Data points to the right of the vertical line are projections into the future.

You can see costs for:

- On-Demand Compute
- RI Compute
- Spot Compute
- On-Demand License
- Reserved License
- Storage
- IP (static IPs for workloads)

This chart reflects on-demand costs for VMs based on uptime and other factors. For details about on-demand cost calculations, see [Estimated On-demand Monthly Costs for Cloud VMs](#).

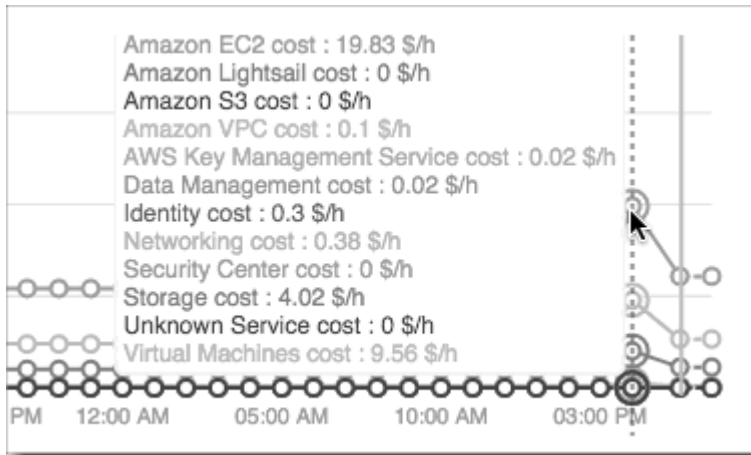
Chart Type

You can set the display to:

- Line Chart
- Stacked Bar Chart
- Area Chart

Reading a Cost Breakdown Chart

The chart tracks cost over time and displays a tooltip with the date for the data point and the given values.



Cost information comes from billing reports. As you change the time scale, Turbonomic divides the reported information into the appropriate time units to match that scale. However, the source remains the same - Changing the scale does not affect the source data, or increase data polling.

Cloud Tier Breakdown Charts

Cloud Tier charts show the cloud tiers that Turbonomic discovers for the chart widget scope. For example, if the Chart Widget Scope is set to All Cloud VMs and the Entity Type is set to Virtual Machine, the chart shows all the cloud tiers that the workloads use.

Entity Type

You can choose any entity type in the list.

Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Location Charts

Location charts show cloud provider regions in a world map for which there are discovered workloads. Click on any region to examine more detailed information in a scoped view.

Display

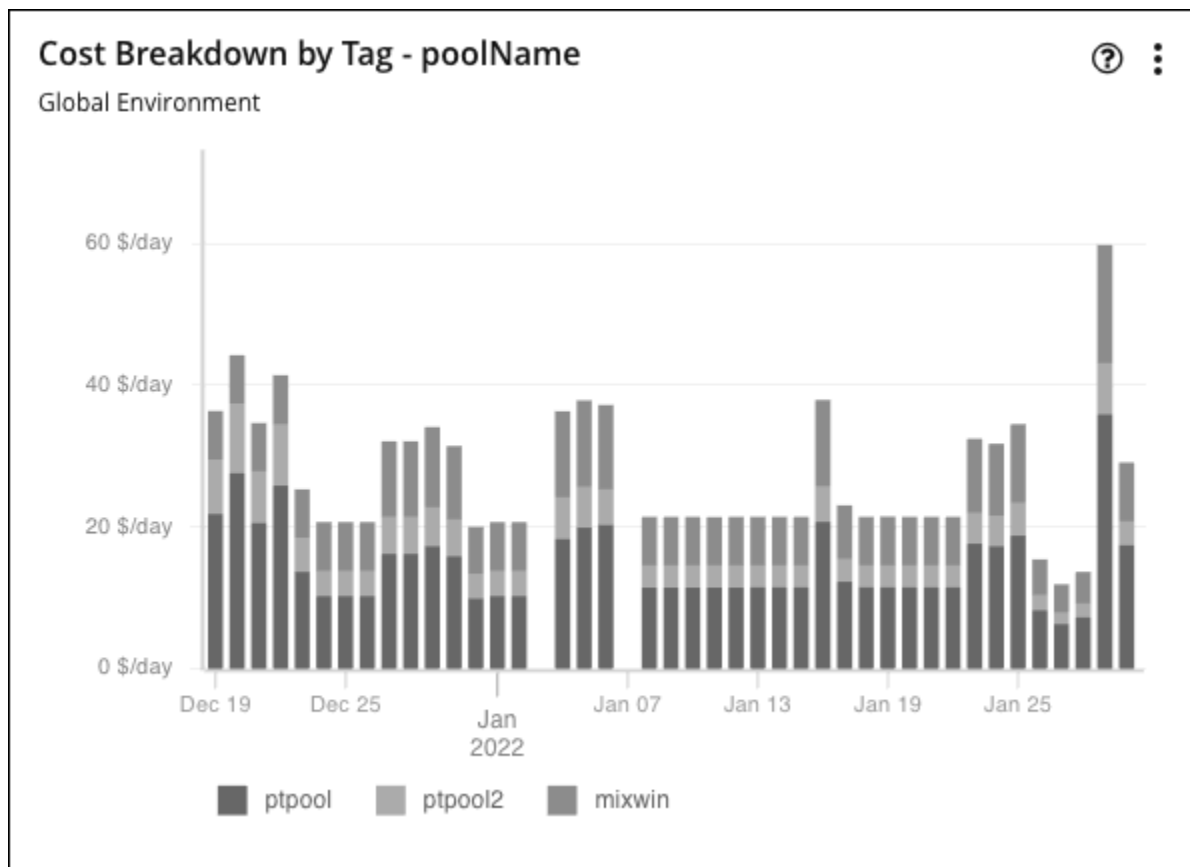
The chart shows the regions in countries in a Map chart.

Cost Breakdown by Tag Charts

Cost Breakdown By Tag charts show the costs for tagged cloud entities that Turbonomic has discovered in your Azure or GCP environment. For the tagged entities in scope, the chart shows how daily costs change over time.

You choose a tag key to track, and then choose which tag values to include in the chart. Each data point aggregates the costs for all the entities with a given tag/value pair. You can display the cost breakdown in a stacked bar chart or an area chart.

Example: For this stacked bar chart, the tag **poolName** is *workload-type* and the tag **Values** are *ptpool*, *ptpool2*, and *mixwin*.



Scope

To display these charts, add them to the default views in the Home Page or to your custom dashboards. By default, these charts are scoped to your global environment. You can change the scope to view granular data.

Timeframe

Set the amount of historical data the chart will show.

Chart Type

You can set the display to:

- Area Chart
- Stacked Bar Chart

For more detail, hover over a data point. A tooltip appears to show specific values for that date. Click the legend items to show/hide data for specific values.

Tag Settings

Choose the Tag/Value pairs you want to display in the chart.

Note that tag Key and Value are case insensitive. Each data point in the chart aggregates the costs for all entities with the given tag Key/Value pair, regardless of case.

- **Key**

The tag name that you want to chart. Turbonomic discovers the tags you have configured in your environment.

You can choose one Key for the chart.

- **Values**

The values that you have configured in your environment for the given Key.

You can choose multiple values. To shorten the list of values, type a filter string in the Values field.

Cumulative Savings and Investments Charts

Actions for your cloud workloads usually have cost savings or investments attached to them. For example, deleting unattached volumes can lower your costs significantly (savings), while scaling a VM to a different tier to improve performance could incur additional costs (investments).

These charts highlight:

- Total *realized* savings and investments as a result of executing actions
- Total *missed* savings and investments when actions are not executed

Information in these charts can help shape your action handling policies. For example, you can start automating actions so you don't miss opportunities to assure performance at the lowest possible cost.

Scope

These charts display in the built-in Cloud Executive Dashboard and are scoped to your global environment. You can change the scope to view granular data. You can also add these charts to the default views in the Home Page or to your custom dashboards.

Another way to view granular data is to set the scope (in the supply chain or by using Search) to one or several accounts, billing families, groups, or workloads.

Scale Actions

For actions to scale workloads (VMs, Database Servers, databases, or volumes), Turbonomic calculates savings and investment *per workload* based on the hourly cost of the workload price difference, taking into account workload uptime and the effect of consecutive scale actions on the same workload.

- Calculated investments and savings are the total of all past scaling actions, with the exception that a scale in one direction reduces the amounts of previous actions in the opposite direction, until one or more previous actions have no more effect.

To illustrate:

Consider three consecutive scale actions for a VM and their effect on the calculation.

1. A cost increase of \$1.00 counts as an investment of \$1.00.
2. A subsequent cost decrease of \$0.25 is factored in as:
 - Savings of \$0.25 to the total amount in the Cumulative Savings chart
 - An investment of \$0.75 to the total amount in the Cumulative Investments chart
3. Another cost decrease of \$1.00 is factored in as:
 - Savings of \$1.25 to the total amount in the Cumulative Savings chart

- An investment of \$0.00 to the total amount in the Cumulative Investments chart

By the time the third action was executed, the initial \$1.00 investment has been "undone" (investment amount is \$0.00) and is no longer considered when calculating savings and investments for the VM.

- Calculation temporarily stops for the hours that a workload is offline, and then resumes when the workload is online again and is running with the same configuration.
- Calculation stops for terminated workloads or workloads that Turbonomic no longer discovers.

Volume Delete Actions

For actions to delete volumes, Turbonomic calculates savings accumulated over one year since volume deletion, based on the hourly cost of the deleted volume. It also estimates missed savings based on the hourly cost of the workload price difference and the number of hours that pending actions remain in the system.

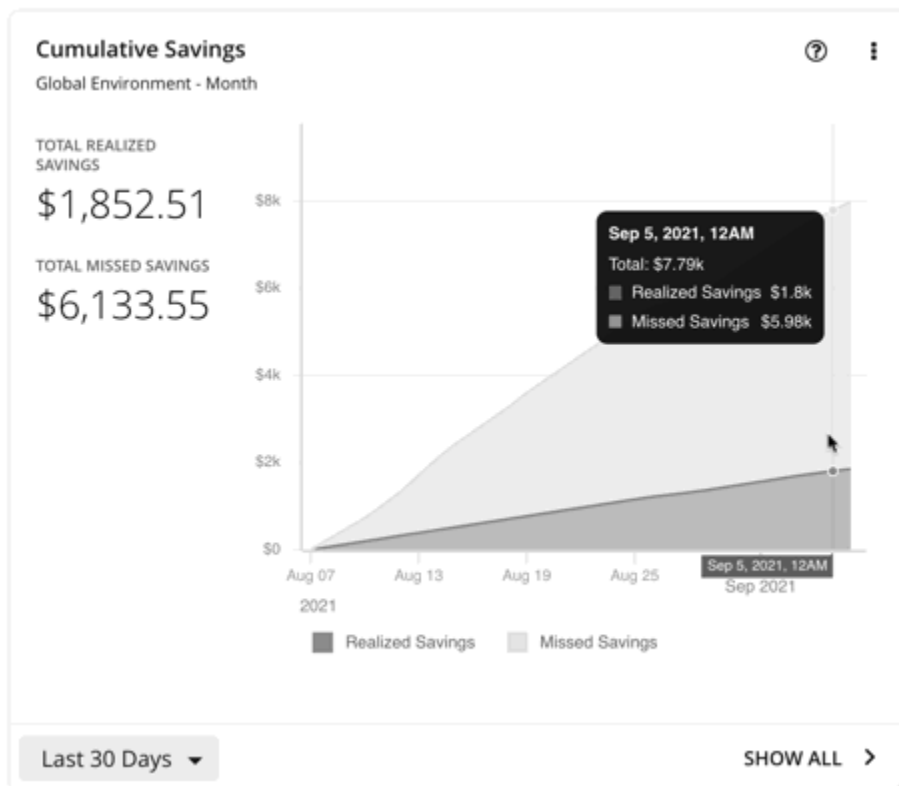
Chart Type

You can set the display to:

- Text and Area Chart
- Area Chart
- Text and Bar Chart
- Stacked Bar Chart
- Text

You can edit the chart to switch between the **Cumulative Savings** and **Cumulative Investments** views. You can also change the displayed data to just **Savings** or **Investments** if you do not wish to see how the savings or investment costs accumulate over time.

In this example, Turbonomic shows monthly realized and missed savings.



In the chart legend, you can click **Realized Savings** or **Missed Savings** to display a filtered view. Click the item again to reset the chart.

Click **Show All** at the bottom of the chart to view and download data in tabular format.

Savings and Investments Charts

Actions for your cloud workloads usually have cost savings or investments attached to them. For example, deleting unattached volumes can lower your costs significantly (savings), while scaling a VM to a different tier to improve performance could incur additional costs (investments).

These charts highlight:

- Total *realized* savings and investments as a result of executing actions
- Total *missed* savings and investments when actions are not executed

Information in these charts can help shape your action handling policies. For example, you can start automating actions so you don't miss opportunities to assure performance at the lowest possible cost.

Scope

To display these charts, add them to the default views in the Home Page or to your custom dashboards. By default, these charts are scoped to your global environment. You can change the scope to view granular data.

Another way to view granular data is to set the scope (in the supply chain or by using Search) to one or several accounts, billing families, groups, or workloads.

Scale Actions

For actions to scale workloads (VMs, Database Servers, databases, or volumes), Turbonomic calculates savings and investment *per workload* based on the hourly cost of the workload price difference, taking into account workload uptime.

- Calculation temporarily stops for the hours that a workload is offline, and then resumes when the workload is online again and is running with the same configuration.
- Calculation stops for terminated workloads or workloads that Turbonomic no longer discovers.

Volume Delete Actions

For actions to delete volumes, Turbonomic calculates savings since volume deletion, based on the hourly cost of the deleted volume. It also estimates missed savings based on the hourly cost of the workload price difference and the number of hours that pending actions remain in the system.

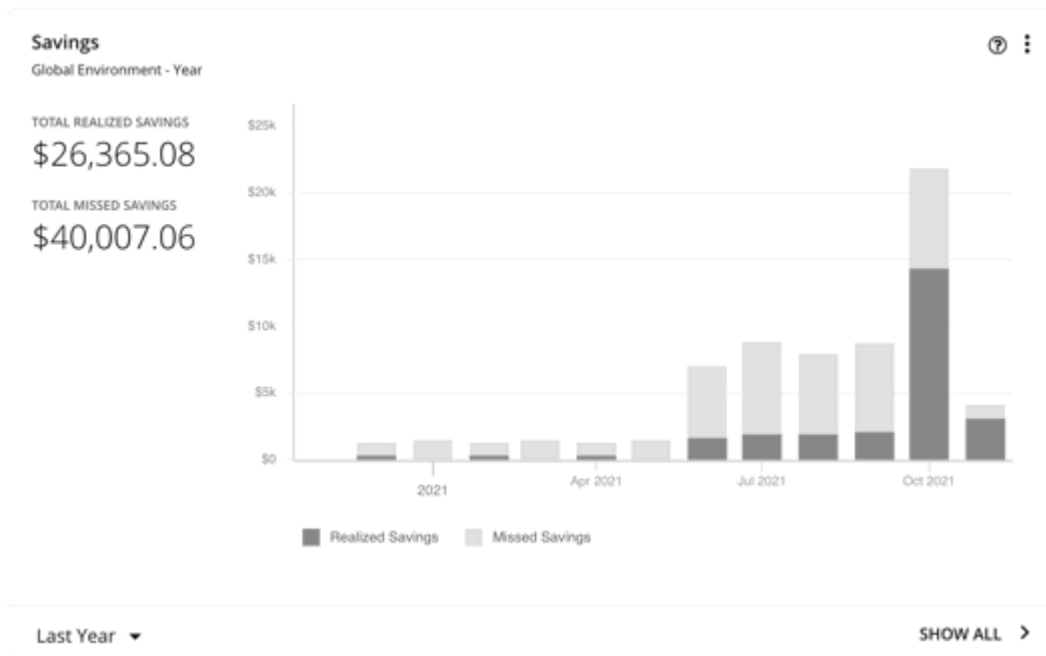
Chart Type

You can set the display to:

- Text and Area Chart
- Area Chart
- Text and Bar Chart
- Stacked Bar Chart
- Text

You can edit the chart to switch between the **Savings** and **Investments** views. You can also change the displayed data to **Cumulative Savings** or **Cumulative Investments** to see how the savings or investment costs accumulate over time.

In this example, the chart shows realized and missed savings per month over the last year. It indicates higher rates of realized savings in the last two months as more actions are executed rather than kept pending.



In the chart legend, you can click **Realized Savings** or **Missed Savings** to display a filtered view. Click the item again to reset the chart.

Click **Show All** at the bottom of the chart to view and download data in tabular format.

Recommended RI Purchases Charts

Recommended RI Purchases charts show the projected inventory of pending Reserved Instance purchases as generated by Turbonomic. The charts show the Reserved Instance workloads that Turbonomic discovers, and lists them by the available templates.

To see the RI information for each template, click **Show all** at the bottom of the chart. If your scope includes both AWS and Azure cloud targets, click **AWS** or **Azure**. Click any column heading to sort the list. For example, you can sort the list by the break-even period (The time at which RI savings will exceed the purchase cost of the RI, rounded to the month). When you choose one or more checkboxes, the total count, up-front cost, and savings appear at the top.

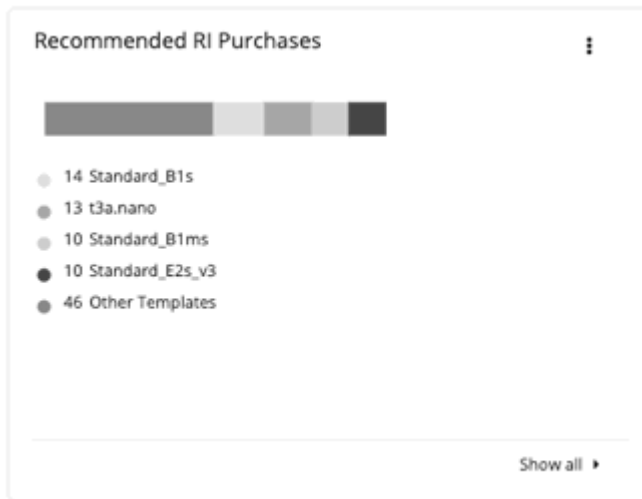
Chart Type

You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Examples:

- Horizontal Bar



- Viewing the AWS **Show all** list

AWS AZURE											
Buy Actions 20 Savings \$799/mo										EXECUTE ACTIONS	↓
Type to search										ADD FILTER	
<input type="checkbox"/> Account	Instance Type	Count	Platform	Term	Payment	Region	Up-Front Cost ⓘ	Break Even Period ⓘ	Action Category	Cost Impact ↓	Action
<input type="checkbox"/> Advanced	r5a.large	8	Linux	1 Year	All Upfront	aws-US West (N. C.	\$5,192	8 months	SAVINGS	↓ \$210/mo	DETAILS
<input type="checkbox"/> Advanced	c5a.large	6	Linux	1 Year	All Upfront	aws-US West (N. C.	\$2,934	7 months	SAVINGS	↓ \$171/mo	DETAILS
<input type="checkbox"/> Advanced	r5a.large	5	Linux	1 Year	All Upfront	aws-US East (Ohio)	\$2,910	8 months	SAVINGS	↓ \$133/mo	DETAILS

- Viewing the Azure **Show all** list

AWS

AZURE

Buy Actions 27 Savings \$928/mo

EXECUTE ACTIONS

Q

Type to search

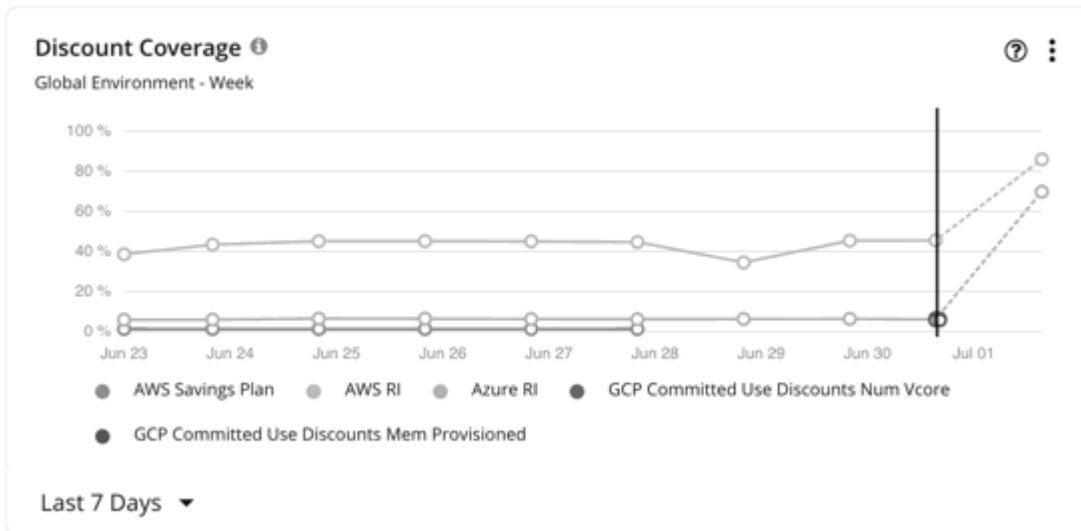
ADD FILTER

<input type="checkbox"/> Subscription	Product Name	Quan...	Term	Region	Up-Front Cost ⓘ	Break Even Period ⓘ	Action Category	Cost Impact ↓	Action
<input type="checkbox"/> Dev	Standard_D2s_v3	6	1 Year	azure-North Central	\$3,042	7 months	SAVINGS	↓ \$173/mo	DETAILS
<input type="checkbox"/> Dev	Standard_B1ls	49	1 Year	azure-East US	\$1,323	7 months	SAVINGS	↓ \$73/mo	DETAILS
<input type="checkbox"/> Dev	Standard_DS1_v2	2	1 Year	azure-Brazil South	\$798	6 months	SAVINGS	↓ \$57/mo	DETAILS

Discount Coverage Chart

This chart shows the percentage of VMs covered by:

- AWS Reserved Instances (RIs) and Savings Plans
- Azure reservations
- GCP committed use discounts



If you have a high percentage of on-demand VMs, you should be able to reduce your monthly costs by increasing coverage. To increase coverage, you scale workloads to instance types that have existing capacity.

For AWS and Azure, Turbonomic will recommend purchasing additional discounts if you need more capacity. For GCP, purchase recommendations will be introduced in a future release.

AWS RIs

If you set the scope to a specific AWS account, the chart shows the RI coverage for the workloads for the account, plus any RIs for the billing family.

The data point on the solid vertical line shows the latest data that was polled from your environment. Data points to the left of the vertical line represent historical data, while data points to the right are projections into the future.

Hover on a data point in the chart to see the following information:

- The date and time for the data point
- The percentage of coverage, based on [NFUs](#)

NFU is a measure of RI capacity that you can use to compare or combine the capacity for different instance families.

Turbonomic measures RI coverage in terms of these normalized factors. The chart shows the number of RIs calculated as NFUs that cover workload capacity compared to the total number of NFUs for the workloads in the chart's scope. Each workload is assigned normalized factor units depending on its instance type.

AWS Savings Plans

To view data for AWS Savings Plans, you must:

- Set the scope to your global environment.
- Choose a timeframe that shows daily or monthly data points (Last 7 Days, Last 30 Days, or Last Year)

AWS measures your Savings Plans commitment in \$/hour, but shows daily and monthly costs in Cost Explorer. Turbonomic polls Cost Explorer periodically to obtain the latest cost data, and then uses that data to calculate Savings Plans utilization or coverage *per day*. For this reason, you will not see Savings Plans data if you choose a timeframe that shows hourly data points (Last 2 Hours or Last 24 Hours).

Note:

AWS timestamps data in UTC, but the chart presents data in your local time. This difference could result in the appearance of a missing day in the chart, but has no effect on data completeness (the chart always reflects the complete data set).

The chart shows historical data, represented by data points to the left of the solid vertical line. Data for the current day is not available since the latest data that AWS provides is always a few days old. In addition, Turbonomic does not project coverage into the future.

Hover on a data point in the chart to see the following information:

- The date and time for the data point
- The percentage of coverage

Azure Reservations

If you set the scope to a specific Azure subscription, this chart shows the reservation coverage for the workloads for the subscription, plus any shared reservations and single-scope reservations owned by this subscription.

The data point on the solid vertical line shows the latest data that was polled from your environment. Data points to the left of the vertical line represent historical data, while data points to the right are projections into the future.

Hover on a data point in the chart to see the following information:

- The date and time for the data point
- The percentage of coverage, based on [ratios](#).

Ratio refers to the number of reservation units that cover workload capacity compared to the total number of reservation units for the workloads in the chart's scope. Each workload is assigned reservation units based on its instance type.

GCP Committed Use Discounts

The chart displays the latest data that was polled from your environment, but does *not* show historical data or project coverage into the future.

Hover on a data point in the chart to see the following information:

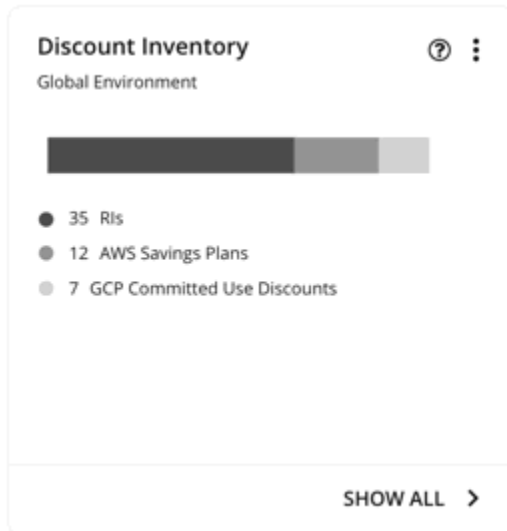
- The date and time for the data point
- The percentage of coverage

Discount Inventory Chart

Turbonomic discovers the following discounts provided by cloud providers:

- AWS Reserved Instances (RIs) and Savings Plans for regular and [GovCloud](#) workloads
- Azure reservations for regular and [Azure Government](#) workloads
- GCP committed use discounts

Chart Type



You can set the display to:

- Text
- Ring Chart
- Horizontal Bar

Show All

Click **Show All** at the bottom of the chart to see detailed information for the discounts in scope. If your scope includes multiple cloud providers, each provider will have its own tab.

Discount Inventory

AWS RESERVED INSTANCES

AWS SAVINGS PLANS

AZURE RESERVED INSTANCES

GCP COMMITTED USE DISCOUNTS

Total 8 Count 12 Cost \$1,790.83/mo Savings \$1,434.16/mo

<input type="checkbox"/> Reservation ID	Account	Instance Type	Count	Location	Platform	Tenancy	Class	Payment	Current Utilization	Est. Savings	Term	Exp. Date	Effective Cost	Li... VMs	
<input type="checkbox"/>		Quality Engin	t3.nano	1	aws-ap-northe	Linux	Default	Convertible	All Upfront	0%	\$0.00/mo	1 Year	Nov 02, 2022	\$3.67/mo	0 VM
<input type="checkbox"/>		Quality Engin	t3.nano	1	aws-ap-northe	Linux	Default	Convertible	All Upfront	0%	\$0.00/mo	1 Year	Nov 02, 2022	\$3.67/mo	0 VM
<input type="checkbox"/>		Development	t3.micro	1	aws-US East (Linux	Default	Convertible	No Upfront	<div>100%</div>	\$2.12/mo	1 Year	Feb 28, 2023	\$5.48/mo	1 VM

Each row in the table corresponds to a discount. Note that there can be several discounts for an Azure subscription or AWS/GCP account, and each discount displays as its own row. Table columns show basic information obtained from the cloud provider, such as the name/ID of the discount, the subscription/account that uses that discount, instance type and location, term, and expiration dates. Click a subscription/account to narrow the scope.

The table supports the following general functionality:

- **Totals:** At the top of the page, you will see the total number of discovered discounts. For AWS RIs and Azure reservations, you will also see total costs and savings. As you select one or more checkboxes, the information changes to reflect the totals for your selections.
- **Column Sorting:** Click any column heading to sort the list.
- **Download:** Click the Download icon at the upper right section of the page to download the table as a CSV file.

Azure Reservations and AWS RIs

When you add an Azure EA account or an AWS master account as your primary cloud target, Turbonomic gains full insight into the discounts for your billing families. Even as you selectively add Azure subscriptions or AWS member accounts as secondary targets, Turbonomic remains aware of all discounts and how they are utilized across the board, and can thus recommend more accurate discount optimization and purchase actions.

Points to consider:

- For AWS, if you added some member accounts as targets, but not a master account, Turbonomic will not reflect discounts for member accounts that you have not added as targets.
- For Azure:
 - It could take Turbonomic up to a day to discover newly purchased Azure reservations.
 - There can be delays in billing information updates that Azure makes available to Turbonomic. If this happens, analysis might use partial billing data in its calculations and show incomplete costs for discounts from non-added Azure subscriptions.

Set the scope to your global environment to view the full inventory. When you click **Show All** at the bottom of the chart, pay attention to the following information shown in the table:

- For discounts in *added* accounts (Azure subscriptions or AWS member accounts):

Reservation ID	Subscription	Name	Product Name	Quantity	Location	Scope	Current Utilization	Est. Savings	Term	Exp. Date	Effective Cost	Linked VMs
	EA - Dev	Standard_DS2_v2_renewed	Standard_DS...	1	azure-East US 2	Shared	100%	\$29.14/mo	1 Year	Aug 24, 2022	\$54.08/mo	1 VM *
	EA - Dev	Standard_DS2_v2_renewed	Standard_DS...	1	azure-East US 2	Shared	100%	\$29.14/mo	1 Year	Sep 03, 2022	\$54.08/mo	1 VM *
	EA - Dev	Standard_D2as_v4_renewed	Standard_D2a...	1	azure-East US 2	Shared	100%	\$28.33/mo	1 Year	Sep 03, 2022	\$41.75/mo	1 VM
	EA - Dev	Standard_F1s_renamed_renewed	Standard_F1s	1	azure-East US 2	Shared	100%	\$9.20/mo	1 Year	Sep 03, 2022	\$27.08/mo	1 VM *

- **Subscription** column (for Azure) or **Account** column (for AWS)

This column shows the account name for the discount. Click the name to set the scope to that account. Note that there can be several discounts for an account, and each discount displays as its own row.

Note:

If there is a failure to re-validate the account for some reason, Turbonomic shows it as a *non-added* account in the Discount Inventory page.

- **Current Utilization** column

This column shows the percentage of discount capacity currently used by VMs in all accounts. Turbonomic estimates the percentage if there are VMs in non-added accounts that use the discount (since the exact number of VMs is unknown).

- **Linked VMs** column

This column shows how many VMs in the account use the discount. Click the number to view the VMs.

A star symbol (*) after the number indicates that there are VMs from *non-added* accounts that also use the discount. Since you have not added those accounts, the exact number of VMs is unknown.

- For discounts in *non-added* accounts:

Reservation ID	Subscription	Name	Product Name	Quantity	Location	Scope	Current Utilization	Est. Savings	Term	Exp. Date	Effective Cost	Linked VMs
	9224a	Standard_F1s...	Standard_F1	1	azure-East US 2	Shared	0%	\$0.00/mo	1 Year	Aug 24, 2022	\$27.08/mo	0 VM
	9224a	Standard_F1s...	Standard_F1s	1	azure-East US 2	Shared	0%	\$0.00/mo	1 Year	Aug 24, 2022	\$27.08/mo	0 VM
	acbc8	Standard_D2s...	Standard_D2a_v4	2	azure-East US 2	acbc86dd-2dk	38%	\$21.25/mo	1 Year	Aug 24, 2022	\$83.50/mo	—

- **Account** column (for AWS) or **Subscription** column (for Azure)

This column shows a grayed-out, non-clickable name to indicate that you have not added the account as a target. Turbonomic is aware of this account and if the given discount is shared with other accounts because you have added a master or EA account.

– **Current Utilization** column

This column shows the percentage of discount capacity currently used by VMs in all accounts. Turbonomic estimates the percentage if there are VMs in non-added accounts that use the discount (since the exact number of VMs is unknown).

– **Linked VMs**

If the number under this column is 1 or more, the number indicates VMs from *added accounts* that use the discount. Click the number to view the VMs.

If the number is 0 (zero), then the discount is currently not used anywhere.

A hyphen symbol (–) indicates that there are VMs from other *non-added* accounts that also use the discount. Since you have not added those accounts, the exact number of VMs is unknown.

AWS Savings Plans

If you added targets that are AWS accounts with read-only access to the AWS Savings Plans API, Turbonomic uses this chart to present the Savings Plans that it discovered in your cloud environment (including GovCloud) and the instance types they use.

<input type="checkbox"/> Savings Plan ID	Account ⓘ	Type	Payment	Instance Family	Location	Commitment	Term	Start Date	Exp. Date
<input type="checkbox"/> 55555 ...	Prod	Compute	All Upfront	All	All	\$0.001/hr	1 Year	Dec 28, 2020	Dec 28, 2021
<input type="checkbox"/> 45555 ...	Prod	EC2	No Upfront	t3	aws-...	\$0.001/hr	3 Years	Dec 29, 2020	Dec 29, 2023

GCP Committed Use Discounts

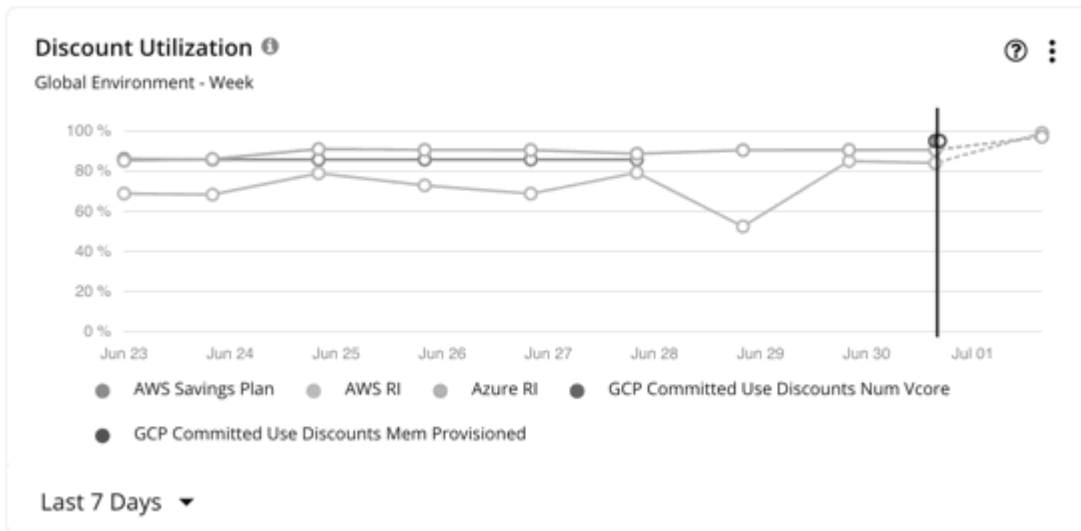
Turbonomic discovers committed use discounts for your workloads when you add the following as targets:

- A service account with the "Billing Account Viewer" role to the related billing accounts
- Billing accounts

<input type="checkbox"/> Name	Account ⓘ	Status	Region	Type	Payment	Instance Family	Cores	Memory	Term	Start Date	End Date
<input type="checkbox"/> commitment-1		Active	us-west4	Family Scoped	All upfront	N2	1	4 GB	3 Years	Oct 15, 2021	Oct 15, 2024
<input type="checkbox"/> commitment-1		Active	europa-north1	Family Scoped	All upfront	N2	1	2 GB	1 Year	Oct 21, 2021	Oct 21, 2022
<input type="checkbox"/> commitment-1		Active	northamerica-northe	Family Scoped	All upfront	N2D	N/A	2 GB	1 Year	Jan 27, 2022	Jan 27, 2023
<input type="checkbox"/> commitment-2		Active	us-central1	Family Scoped	All upfront	E2	N/A	4 GB	1 Year	Oct 21, 2021	Oct 21, 2022

Discount Utilization Chart

This chart shows how well you have utilized your current discount inventory. The desired goal is to maximize the utilization of your inventory and thus take full advantage of the discounted pricing offered by your cloud provider.



AWS RIs

You can set the scope to your global cloud environment or to individual accounts, billing families, or regions. Scoping to an account shows the RI utilization for the workloads for the entire billing family.

The data point on the solid vertical line shows the latest data that was polled from your environment. Data points to the left of the vertical line represent historical data, while data points to the right are projections into the future.

Hover on a data point in the chart to see the following information:

- The date and time for the data point
- The percentage of coverage, based on [NFUs](#)

NFU is a measure of RI capacity that you can use to compare or combine the capacity for different instance families.

Turbonomic measures RI utilization in terms of these normalized factors. The chart shows the number of RIs calculated as NFUs that are consumed by cloud workloads compared to the total number of RIs in the chart's scope.

AWS Savings Plans

To view data for AWS Savings Plans, you must:

- Set the scope to your global environment.
- Choose a timeframe that shows daily or monthly data points (Last 7 Days, Last 30 Days, or Last Year)

AWS measures your Savings Plans commitment in \$/hour, but shows daily and monthly costs in Cost Explorer. Turbonomic polls Cost Explorer periodically to obtain the latest cost data, and then uses that data to calculate Savings Plans utilization or coverage *per day*. For this reason, you will not see Savings Plans data if you choose a timeframe that shows hourly data points (Last 2 Hours or Last 24 Hours).

Note:

AWS timestamps data in UTC, but the chart presents data in your local time. This difference could result in the appearance of a missing day in the chart, but has no effect on data completeness (the chart always reflects the complete data set).

The chart shows historical data, represented by data points to the left of the solid vertical line. Data for the current day is not available since the latest data that AWS provides is always a few days old. In addition, Turbonomic does not project coverage into the future.

Hover on a data point in the chart to see the following information:

- The date and time for the data point
- The percentage of utilization, based on the total utilized and committed costs per day

Azure Reservations

You can set the scope to your global cloud environment or to individual subscriptions, billing families, or regions. Scoping to a subscription shows the reservations utilization for workloads for the entire billing family or for single and shared subscriptions.

The data point on the solid vertical line shows the latest data that was polled from your environment. Data points to the left of the vertical line represent historical data, while data points to the right are projections into the future.

Hover on a data point in the chart to see the following information:

- The date and time for the data point
- The percentage of utilization, based on [ratios](#).

Ratio refers to the number of reservation units in use compared to the total number of reservation units in the chart's scope. Each workload is assigned reservation units based on its instance type.

GCP Committed Use Discounts

The chart displays the latest data that was polled from your environment, but does *not* show historical data or project utilization into the future.

Hover on a data point in the chart to see the following information:

- The date and time for the data point
- The percentage of utilization

Cloud Estimated Cost Charts

Cloud Estimated Cost charts show estimated monthly costs and investments for the cloud. Monthly cost amounts are summarized as amounts with and without actions.

Display

The chart shows the information as a Text chart.

Storage Summary Charts

To help you manage your costs on the public cloud, these charts show the distribution of storage for the given scope, cost, potential savings, and information about unattached storage. In this way, you can see how storage utilization affects your costs. For these charts, Turbonomic calculates the costs based on the cost information from the cloud targets.

For a detailed breakdown, click **Show all** at the bottom of the chart. If your scope includes both AWS and Azure cloud targets, click **AWS** or **Azure** to see the details. Click any column heading to sort the list. When you choose one or more checkboxes, the total appears at the top.

Note:

For Azure environments with VMs in Scale Sets, for any VMs that are powered off, the associated storage shows a utilization of zero GB. This is an accurate presentation of the data that the Azure environment returns for such a powered-off VM. However, it is likely that some of the storage capacity is currently utilized.

Chart Unit

Choose one of the following:

- **Count** to see how many storage tiers or volumes exist by storage type.

- **Cost** to see the monthly cost by storage type.

Chart Displays

Examples:

- Costs

The chart shows the monthly costs for all storage tiers or volumes. You can also choose **Count** to list how many storage tiers or volumes exist by storage type. This display is available for real-time views and dashboards.

- Unattached Storage

The chart shows how many unattached storage tiers or volumes exist. You can also choose **Cost** to list the monthly costs of the unattached storage. This chart is available for real-time views and dashboards.

Monthly Savings or Investments Totals Charts

Monthly Savings or Investments Totals charts help you examine the monthly savings or investments for executed cloud actions. For example, if an executed action causes an increase in the price, this is an investment. These charts also show the missed monthly savings or missed performance investments that you could have achieved for recommended cloud actions, if you executed them.

For this chart's scope, you can choose an account or subscription, a group of accounts or subscriptions, or use the default, Global Environment. If you use the default Global Environment, the chart will automatically use all cloud accounts for its scope. Other examples of scope settings are: An AWS billing family, an Azure subscription, the All AWS Accounts predefined group, or the All Azure Accounts predefined group.

For all actions except Suspend, savings and investments are estimated based on the hourly cost of workload price differences and 730 hours per month of workload usage. Savings from Suspend actions are estimated based on the hourly cost of workload price differences and actual suspend times as defined in the suspension policy.

Missed savings and investments are estimated based on the hourly cost of workload price differences and the number of hours that recommended actions exist in the system.

Monthly Savings or Investments Totals charts calculate data on a monthly basis since your update of Turbonomic to version 6.4.2. Historical data stored in the database prior to version 6.4.2 is not included.

Chart Type

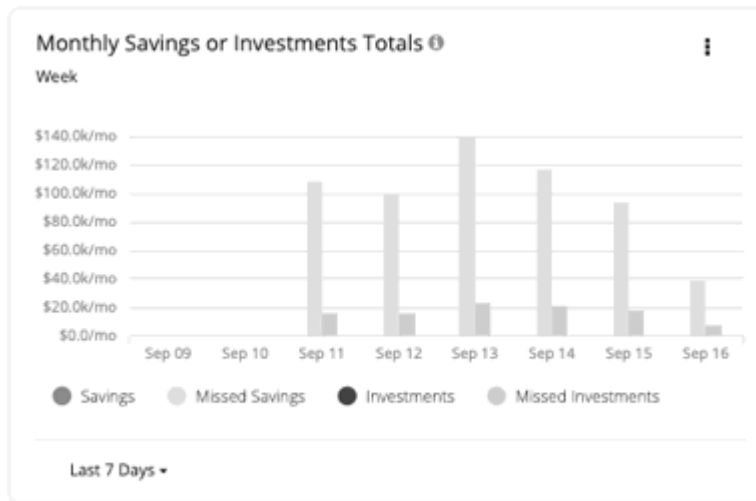
You can set the display to:

- Stacked Bar Chart
- Tabular

Examples:

- Stacked Bar

This chart shows the monthly totals of savings or investments for each of the last seven days. It also shows the missed monthly savings or performance investments that you could achieve by executing recommended cloud actions.



In the chart legend, you can also choose an item to change the display of the chart. Click the item again to reset the chart. For example, if you want to examine investment information, click **Investments** in the legend.

- Tabular

This chart shows the monthly totals of savings or investments for each of the last seven days. It also shows the missed monthly savings or performance investments that you could achieve by executing recommended cloud actions.

Date	Savings	Missed Savi...	Investments	Missed Inve...
Sep 09	\$0/mo	\$0/mo	\$0/mo	\$0/mo
Sep 10	\$0/mo	\$0/mo	\$0/mo	\$0/mo
Sep 11	\$154.76/mo	\$107,763.11/mo.	\$0/mo	\$15,778.08/mo
Sep 12	\$0/mo	\$98,511.93/mo	\$0/mo	\$15,766.58/mo

On-Prem Chart Types

These chart widgets provide information on the status of your on-prem environment.

Density Charts

Density charts show the number of resource consumers (virtual machines or containers) per provider (host or storage). If available, choose the **Show Density** checkbox to see the ratio of consumers to providers.

These charts also show the desired count of virtual machines, assuming you want to fill the headroom completely. Note that the Desired Workloads values are the results of running plans. These plans can calculate workload moves within a cluster to gain more efficiency, but they always respect the cluster boundaries – the plans never move VMs to hosts on different clusters.

To display relevant data, you must set the scope to your global environment or a cluster group. Other scopes are not supported.

To display relevant data, you must set the scope to your global environment or a cluster group. Other scopes are not supported.

Chart Type

You can set the display to:

- Stacked Bar Chart
- Line Chart

Ports Charts

Ports charts show the most utilized northbound or southbound ports in your on-prem environment over a given time period. These charts are useful in Fabric environments where you license port channels.

Display

The chart shows the information as Tabular.

Headroom Charts

Headroom charts show how much extra capacity your clusters have to host workloads.

To calculate cluster capacity and headroom, Turbonomic runs nightly plans that take into account the conditions in your current environment. The plans use the Economic Scheduling Engine to identify the optimal workload distribution for your clusters. This can include moving your current VMs to other hosts within the given cluster, if such moves would result in a more desirable workload distribution. The result of the plan is a calculation of how many more VMs the cluster can support.

To calculate VM headroom, the plan simulates adding VMs to your cluster. The plan assumes a certain capacity for these VMs, based on a specific VM template. For this reason, the count of VMs given for the headroom is an approximation based on that VM template.

You can specify the following types of Headroom charts:

- CPU Headroom
- Memory Headroom
- Storage Headroom

Commodity

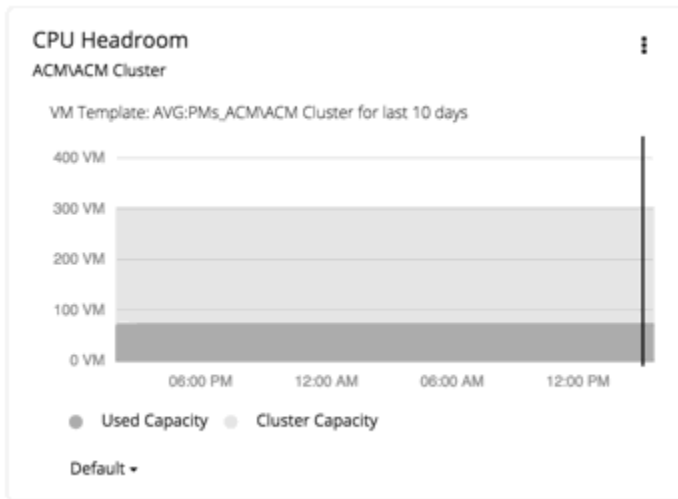
You can choose:

- CPU Headroom
- Memory Headroom
- Storage Headroom

Display

The chart shows the information as an Area chart.

Example:



Exhaustion Time Chart

This chart shows the current growth of workloads and projects when workloads will exceed the capacity of your current infrastructure. This is useful for future planning (for example, if you might need to buy more hardware).

You can track CPU, memory, and storage as well as the average monthly Virtual Machine growth and the average VM template. The amount of time is presented as days. For example, storage will be used up in 41 days.

Display

The chart shows the information as a Text chart.

Embedded Reporting

The Turbonomic platform includes an Embedded Reporting component that you can choose to enable when you install the platform. Use Embedded Reporting to understand application resource management trends, and to share insights with stakeholders via reports and dashboards.

Embedded Reporting runs as its own component, as part of the Turbonomic platform. This architecture enhances performance and reduces storage requirements. It stores a history of your managed environment and then presents selective snapshots of this history via a set of standard dashboards and reports. You can create your own dashboards and reports to focus on other areas of concern.

Dashboards and charts are powered by the Grafana® observability platform. With Grafana, it's easy to navigate the existing dashboards, and to make your own charts and dashboards with no coding required. If you are new to Grafana and need help getting started, read the documentation available at:

<https://grafana.com/docs/grafana/latest/>

Enabling Embedded Reporting

To view and create reports, you must enable Embedded Reporting as part of the Turbonomic installation process. For details, see the Installation Guide.

If you have enabled Embedded Reporting in a Turbonomic instance that is older than version 8.1.1 (7.22.x to 8.1.0), and then updated that instance to version 8.1.1 or later, be aware of the following:

- Version 8.1.1 or later includes a new Embedded Reporting schema that provides additional reporting capabilities.
- Reports will begin their historical data from the time that you completed the update.

- The Embedded Reports page includes a folder named **Old Reports**, which is marked with the date of the update. This folder contains all of your reports before the update, using historical data from before the change to the new schema.
- The **On-Prem Virtual Machine Rightsizing Recommendations** report appears in the **Old Reports** folder, but it is empty. The table used by this report has been rewritten as part of the new schema, and historical data for the report is not saved after you update.
- If you want to merge the old reports with your new reports, please contact your support representative for assistance.

Required Roles

Turbonomic implements role-based access control for Embedded Reporting.

- To manage reports, a user must have the Report Editor role and must *not* be a scoped user. Only one user per Turbonomic instance is allowed to have this role (by default, the local **administrator** user). You can grant Report Editor privileges to another user, from the User Management page.

Note:

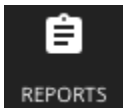
It can take up to 30 minutes before the Reports page shows the Report Editor username. This usually occurs if you have changed the Report Editor multiple times.

- To access reports, a user must have the Administrator or Site Administrator role, or a non-administrator role without a defined scope. For example, a user with the Observer role but without a scope can access reports.

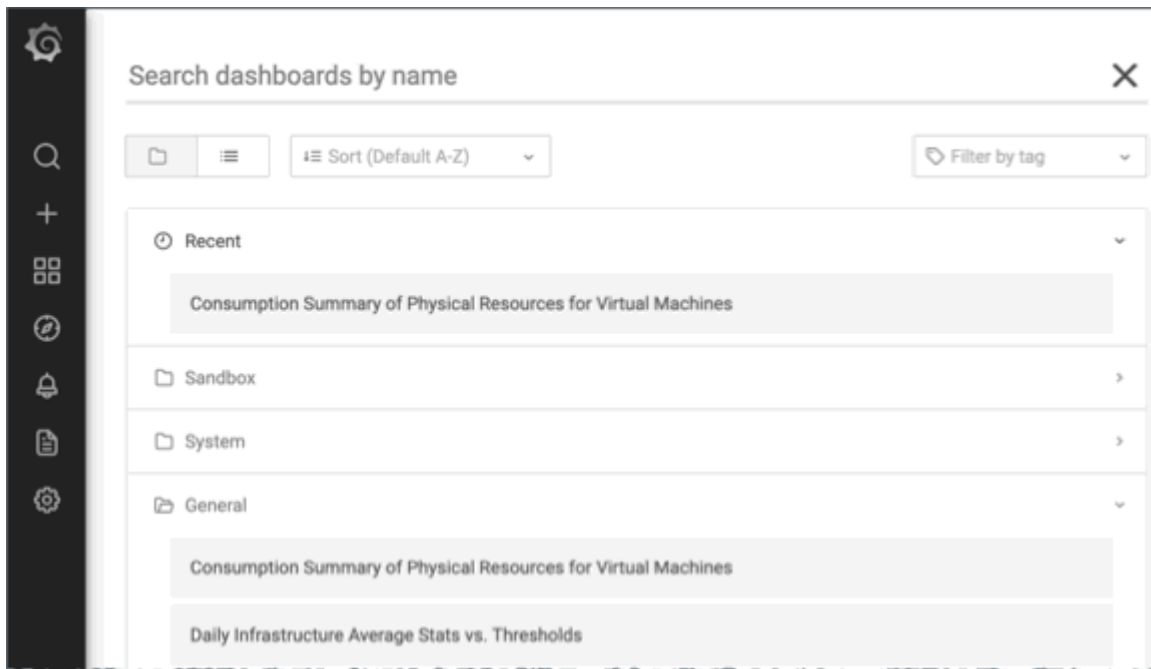
The default Shared Observer and Shared Adviser roles require scopes, so users with these roles cannot access reports.

Embedded Reporting Main Page

When you have enabled Embedded Reporting, the Turbonomic Navigation Bar displays the REPORTS icon.



Click this icon to open the Embedded Reports page in a new browser tab. This tab displays the **Search dashboards by name** view.



You can search for specific dashboards or browse folders to find the dashboards you want. You can also create custom reports.

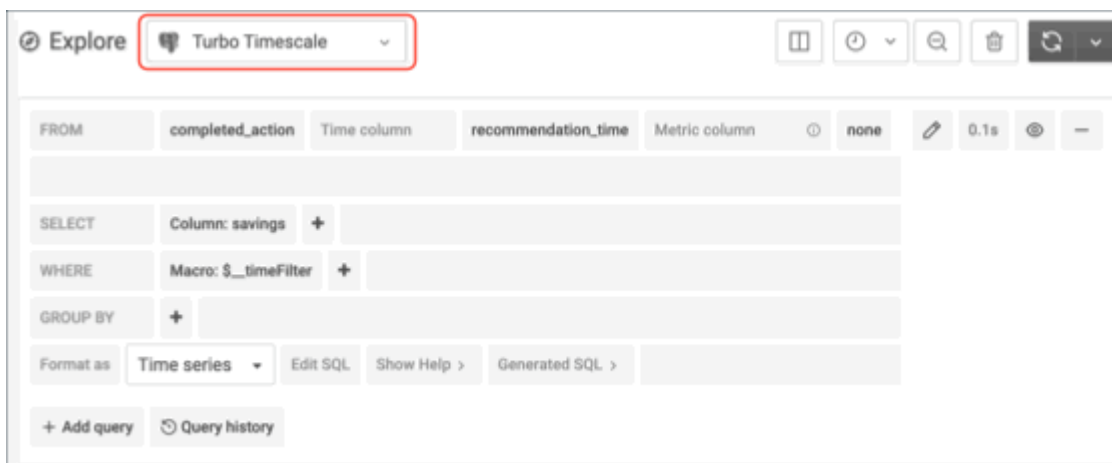
Note:

If you have requested and installed the required Grafana license (free of charge), then users of your Turbonomic installation can view PDF versions of these dashboards.

If a chart in a dashboard includes multiple pages, the PDF file will not contain all the pages of data for that table. This behavior is implemented in Grafana. To generate output for a multi-page table, download the table data as CSV.

Custom Reports

To create custom reports, you must run SQL queries against the Embedded Reports database (Turbo Timescale).



The database schema includes certain tables against which you can run queries. For detailed documentation for the schema, visit:

<https://turbonomic.github.io/reporting-docs/>

Creating Groups

Groups assemble collections of resources for Turbonomic to monitor and manage. When setting scope for your Turbonomic session, you can select groups to focus on those specific resources. For example, if you have a number of VMs devoted to a single customer, you can create a group of just those VMs. When running a planning scenario you can set the scope to work with just that group.

Turbonomic discovers groups that exist in your environment. These groups include PM clusters, and entities grouped by different logical boundaries. For example, Turbonomic discovers Storage by Disk Array, Physical Machines by Datacenter, and VMs by Network. In addition, Turbonomic discovers pools such as virtual datacenters, or folders that implement specific HA policies.

You can also create custom groups. Turbonomic supports two custom-grouping methods:

- **Dynamic** — You define these groups by specific criteria. You can group services according to naming conventions (all VM names that start with **ny**), resource characteristics (all physical machines with four CPUs), or other criteria such as time zone or number of CPUs.

These groups are dynamic because Turbonomic updates the group as conditions change.

- **Static** — You create these groups by selecting the specific group members.

Note:

You should never use the Turbonomic user interface to delete discovered groups. If you do, later analysis cycles will discover them again, and add them to your environment. But until it recreates those groups, any analysis that relies on those groups can give unexpected results.

You *can* delete any custom group you have created. Before you do, you should verify that you do not have any charts, plans, or policies that use the group you want to delete to set their scopes. After you delete the group, such charts, plans, or policies will lose their scope. For example, a policy with no scope has no effect.

To create a group:

1. Navigate to the Settings Page.

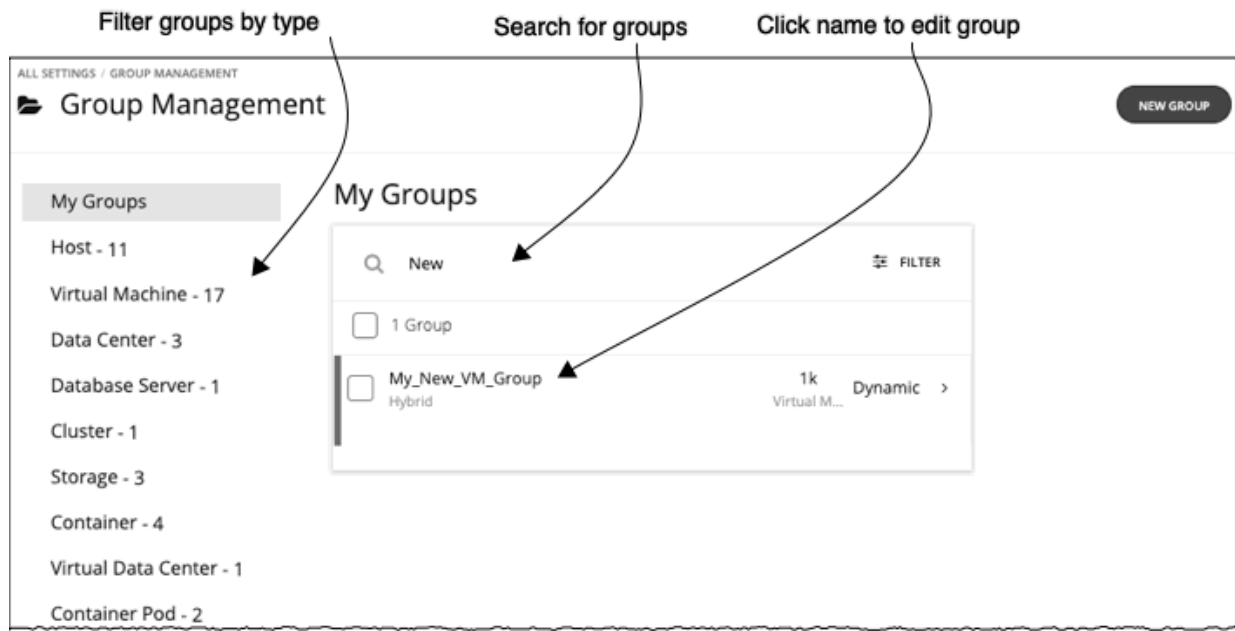


Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. Choose **Groups**.



Click to navigate to the Group Management Page.



This page lists all the custom groups that you currently have configured for Turbonomic. You can:

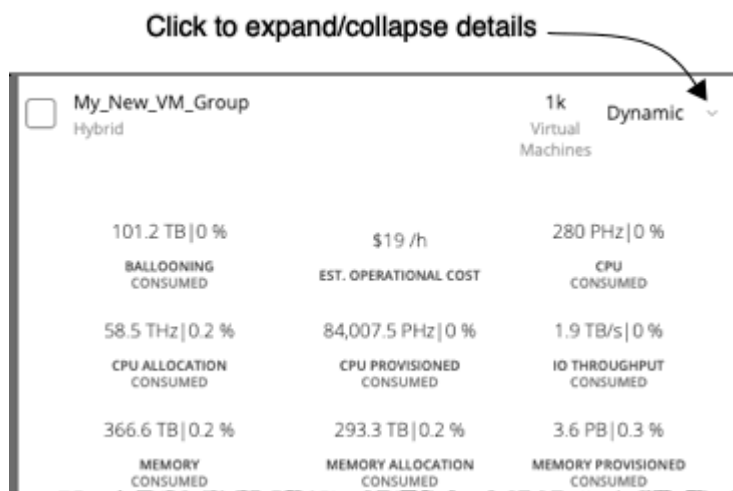
- Expand an entry to see group details
- Select an entry to delete the group
- Click a group name to edit it

For a dynamic group, you can edit the set of criteria that select the group members. For a static group, you can add or subtract specific members.

- Create new groups

To work with a long list of groups, you can filter by group type. For example, only show groups of VMs, or groups of host machines. You can also type a string in the **Search** field to filter the list.

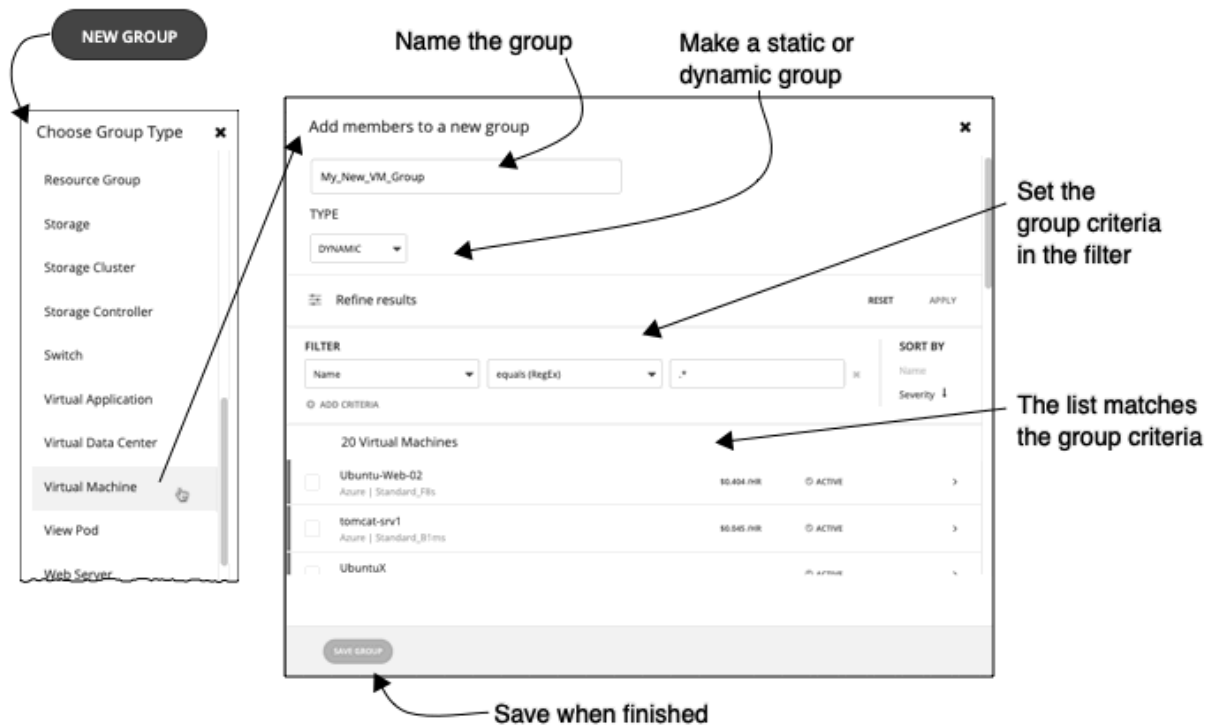
3. Expand an entry to see group details.



The details show you information about related entities such as how many hosts provide resources for a group of VMs. If there are any pending actions for the group, the details list those actions as well.

4. Create a new group.

Click **NEW GROUP**.



Next, choose a group type.

Then, specify the group settings:

- Give the group a unique name. To prevent issues, you should never use duplicate names for groups of the same entity type.
- Set whether the group will be static or dynamic.

To create a static group, select the member entities from the list. To filter the list, set group criteria.

To create a dynamic group, set group criteria. The list updates to show the resulting group members.

- Specify group criteria.

These criteria are entity attributes that determine group membership. You might create a group of all VMs that have 4 VCPUs. You can choose properties of the member entities, and you can choose properties of entities that are related to the members. For example, you can make a group of VMs that are hosted by PMs with the substring "Development" in their names.

As you set criteria, the list of entities updates to show the member entities. You also can sort the list by severity (per the most critical entity in group) or group name.

Note that you can use regular expression to express your match strings.

- When you are finished, save the group.

Save adds this group to the **My Groups** collection.

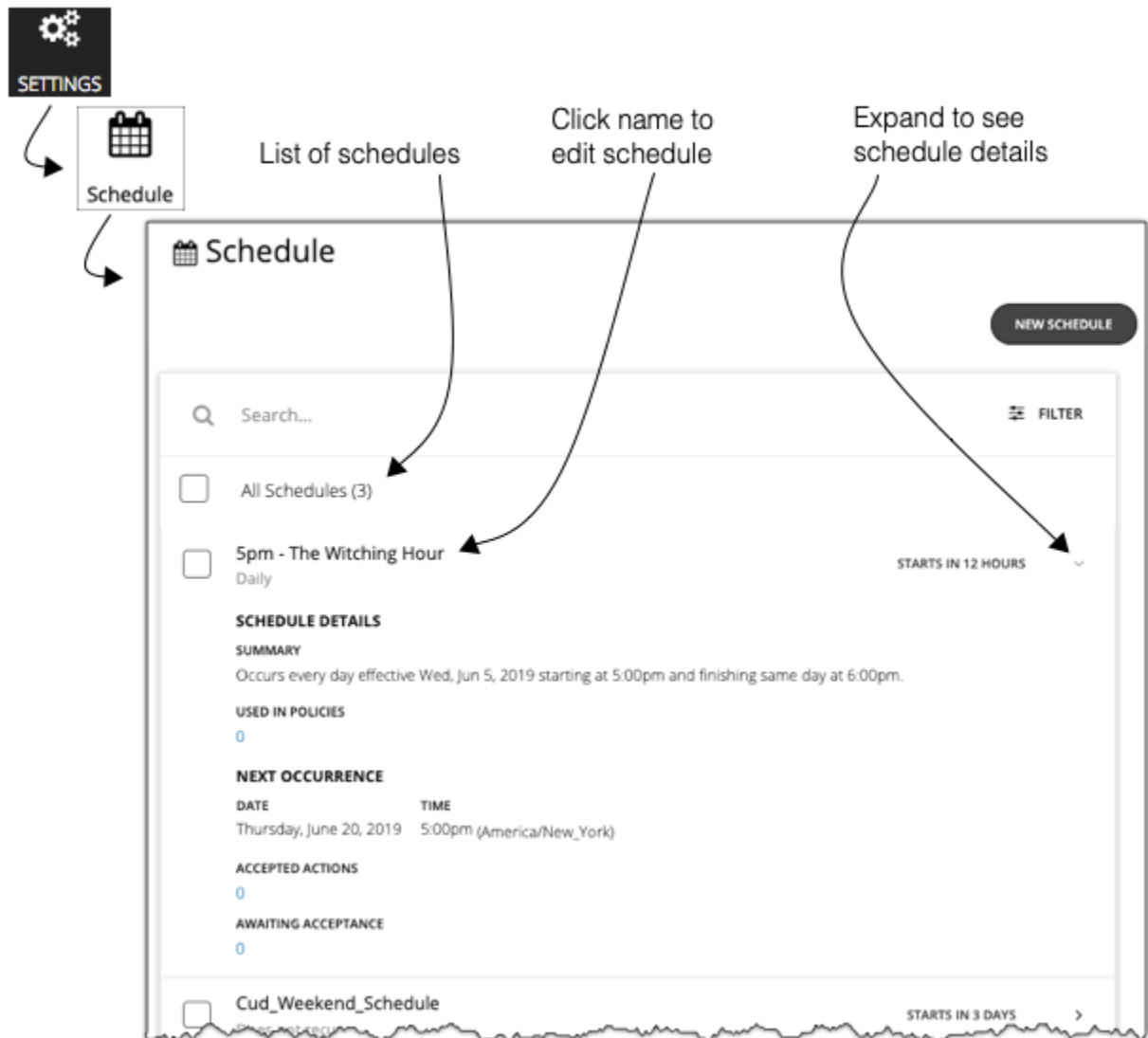
Working With Schedules

Turbonomic schedules specify a specific time range during which certain events can occur. Turbonomic currently uses schedules in scoped policies to set up windows of time when the policy can execute certain actions, or when the policy changes settings that affect analysis and action generation.

Note:

When you configure a schedule window for a VM resize action, to ensure Turbonomic will execute the action during the scheduled time, you must turn off the **Enforce Non Disruptive Mode** setting for that

scheduled policy. Even if you turn the setting off for the global policy, you still must turn the setting off for your scheduled policy. Otherwise Turbonomic will not execute the resize action.



The Schedules page lists all the currently defined schedules. From this page you can:

- Select an entry to delete the schedule.
- Select an entry to defer the next occurrence.

Turbonomic calculates when the next scheduled window will open. If you want cancel the scheduled occurrence one time, you can select the schedule and defer the upcoming occurrence. This defers the schedule wherever it is applied. If the schedule is applied to more than one policy, this will defer all the policies that use this schedule. Before you defer a schedule, you should expand the details and review all the policies that use this schedule.

- Expand an entry to see schedule details

The details include a summary of the schedule definition, as well as:

- **Used in Policies**

The number of policies that use this schedule. Click the number to review the policies.

- **Next Occurrence**

When the schedule will next come into effect.

- **Accepted Actions**

How many scheduled actions have been accepted to be executed in the next schedule occurrence. Click the number for a list of these actions.

– **Awaiting Acceptance**

The number of Manual actions affected by this schedule that are in the Pending Actions list, and have not been accepted. Click the number for a list of these actions.

- Create new schedules

See [Creating Schedules](#).

Deleting Schedules

Before you delete a schedule, you should view its details to make sure no policies use it. If you delete a schedule that is in use by any policies, Turbonomic disables the affected policies until you edit them to either:

- Apply a different schedule to the policy and save the change, or...
- Save the policy with no schedule

Saving with no schedule confirms that you intend for this policy to apply at all times. Because scheduled policies are for special cases, this is usually not what you intend. For example, a scheduled maintenance window can have aggressive action modes that you do not want to enable during peak hours. If you save the policy with no schedule, then the aggressive settings will take effect at all times.

Turbonomic posts a confirmation dialog before deleting a schedule that is currently in use.

Creating Schedules

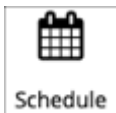
To create a new schedule:

1. Navigate to the Settings Page.



Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. Choose Schedules.



Click to navigate to the Schedule Management Page.

This page lists all the schedules that you currently have configured for Turbonomic. You can edit the schedules in the list, or you can create new schedules.

3. Create a new schedule.

NEW SCHEDULE

Enter Schedule Name ✓ ✕ ✕

RECURRENCE
Does not recur ▴ ▾

START DATE
Wed Jun 19 2019

START TIME **DURATION**
2:00 PM 1 hour(s) 0 minute(s)

TIMEZONE
America/New_York ▴ ▾

SAVE

Click **New Schedule** to open the new schedule fly-out. Then name the schedule.

4. Set the recurrence for the schedule.

Choose whether the scheduled period occurs just once, or whether it repeats over time. The settings vary according to the recurrence you choose:

- Does Not Recur

This is a one-time schedule window. A non-recurring window has a start date, and no end date. The window starts on the day and time you specify, and remains open for the given duration.

- Daily

RECURRENCE
Daily ▴ ▾

REPEAT EVERY
1 days

START DATE **END DATE**
Wed Jun 19 2019 None ▴ ▾

Repeat this schedule every given number of days. For example, repeating 30 days is similar to repeating monthly, except it repeats by the count of days, not by the calendar month.

The schedule begins on the **Start Date**, and continues repeating until the **End Date**. If **End Date** is "None", the schedule repeats perpetually.

- Weekly

RECURRENCE

Weekly

REPEAT EVERY

1 weeks

ON

Mo Tu Wd Th Fr Sa Su

START DATE

Wed Jun 19 2019

END DATE

None

Repeat this schedule every given number of weeks, on the week days you specify. For example, to repeat every weekend, set it to repeat every one week on Saturday and Sunday.

The schedule begins on the **Start Date**, and continues repeating until the **End Date**. If **End Date** is "None", the schedule repeats perpetually.

- Monthly

RECURRENCE

Monthly

REPEAT EVERY

1 months

ON

First

Saturday

START DATE

Wed Jun 19 2019

END DATE

None

Repeat this schedule every given number of months, to begin on a given day in the month. For example, you can schedule a maintenance window to begin on the first Saturday of each month.

The schedule begins on the **Start Date**, and continues repeating until the **End Date**. If **End Date** is "None", the schedule repeats perpetually.

5. Set the Start Time and Duration.

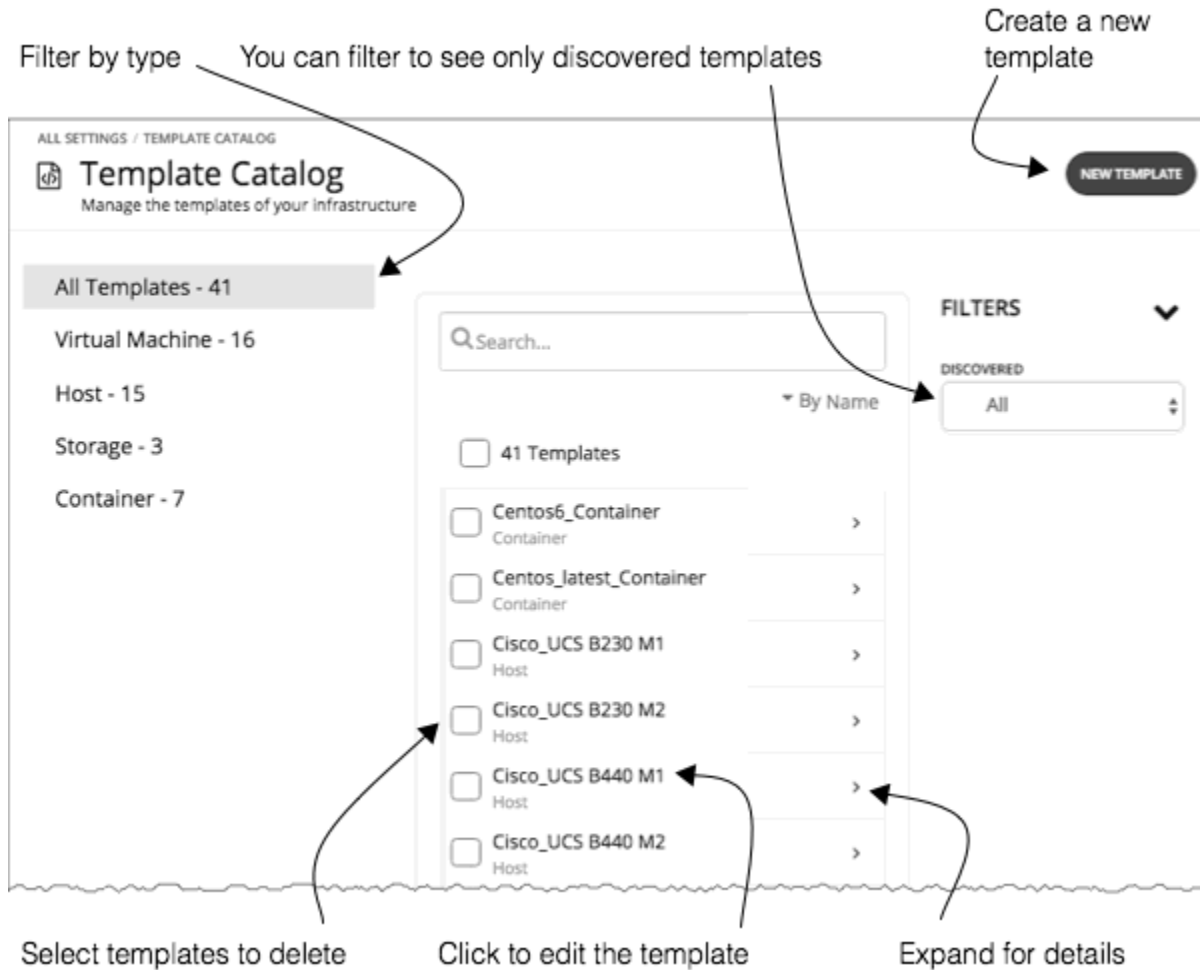
These settings specify how long the scheduled window remains open. You set the duration in terms of hours and minutes. Using a duration instead of an end time removes ambiguities such as starting before midnight and ending after. However, you should make sure the duration is not longer than the recurrence.

6. Set the time zone.

This gives a reference for the schedule's start time. The Turbonomic server uses that reference when it opens and closes the schedule window. Users see the same time zone setting no matter where they are located – They should convert the schedule time to their local time if they want to track when the schedule opens in their working day.

7. When the settings are complete, save the schedule.

Templates: Resource Allocations for New Entities



Turbonomic uses templates to describe new entities that it will deploy in your environment or in plans. The templates specify resource allocations for these entities. For example, you can run a plan that adds new VMs to a cluster. If you add ten copies of a template, then the plan places ten new VMs that match the resource allocation you have specified for the given template. For your cloud environment, you can see templates to match the instance types in your cloud accounts and subscriptions.

A VM template definition can include one or more images that Turbonomic uses to deploy the VM in your environment. The image identifies the actual deployment package, including a path to the physical files (for example an OVA).

The Template Catalog shows all of the templates that have been specified or discovered for your installation of Turbonomic. From this page, you can also create new templates and edit existing ones.

Creating Templates

Templates specify the resources for entities that Turbonomic can deploy in your environment, or in plans.

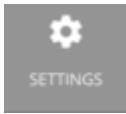
A VM template definition can include one or more images that Turbonomic uses to deploy the VM in your environment. The image identifies the actual deployment package, including a path to the physical files (for example an OVA).

The Template Catalog shows all of the templates that have been specified or discovered for your installation of Turbonomic. From this page, you can also create new templates and edit existing ones.

Creating and Editing Templates

To create a new template, navigate to the Template Catalog and click **NEW TEMPLATE**. To edit a template, click the template's name. When you create a new template, the first step is to choose the entity type.

1. Navigate to the Settings Page.



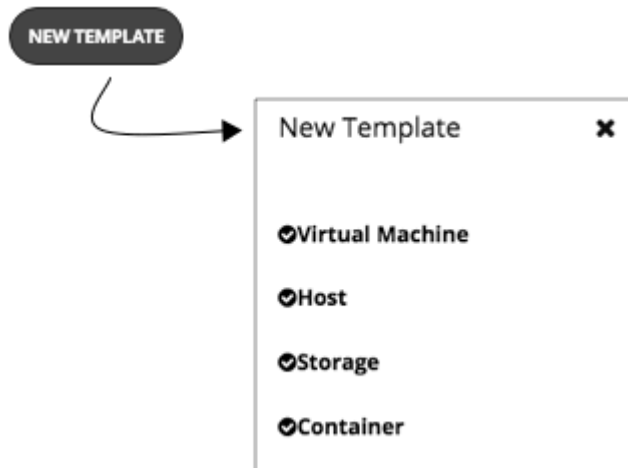
2. Choose Templates.



3. Create or edit a template

To create a new template, navigate to the Template Catalog and click **NEW TEMPLATE**. To edit a template, click the template's name.

4. If you're creating a new template, choose the entity type.



5. Make the settings for your template.

For each type of template, you set allocations for different resources. You can make templates of the following types:

- Virtual Machine
- Host
- Storage
- Container

6. Make the settings for your template, and then save your changes.

When the template window opens, it displays the most common resource settings. You can expand the settings to see the full collection for that template type.

7. Save your changes.

After you have made your settings and named the template, click **CREATE** or **SAVE**.

VM Template Settings

A VM template describes the resource allocation that you want to provide for a type of VMs. When Turbonomic deploys the associated VM to your environment or in a plan, it uses these values to determine the size of the VM. Turbonomic uses the Size settings to calculate the best placement for a VM of this type.

A VM template can optionally include an image description. When Turbonomic uses the template to deploy a VM to your environment, it uses the image to access the actual bits that install as the VM instance.

Note:

Turbonomic generates a special template called *headroomVM*, which it uses to calculate cluster headroom. The Template Catalog shows the template as editable, but you should not edit it because Turbonomic will overwrite your changes the next time it generates the template.

VM Size

- CPU

The virtual CPUs assigned to the VM. Specify the number of **Cores** and the **VCPU** clock speed – Turbonomic multiplies these values to calculate the host CPU resources it will allocate when placing the VM.

The **Utilization** value sets the percentage of allocated CPU that the placed VM will consume. To ensure the host has left over resources for infrastructure tasks, you should assign less than 100%.

- Memory

The amount of memory to allocate for the VM, in MB.

The **Utilization** value sets the percentage of allocated memory that the placed VM will consume. To ensure the host has left over resources for infrastructure tasks, you should assign less than 100%.

Note that you should never allocate less memory than is required for the VM's guest OS.

- Storage

The storage resources to allocate for this VM.

- **disk/rdm** – If you choose **rdm**, then the VM can use VMware Raw Device Mapping for its storage.
- **IOPS** – The capacity for IO operations you give the VM for this datastore.
- **Size** – The amount of storage capacity, in GB.

The **Utilization** value sets the percentage of allocated memory that the placed VM will consume. To ensure the storage has left over resources for infrastructure tasks, you should assign less than 100%.

Note that you can allocate multiple datastores to the VM.

- Network

The amount of the host's network throughput to assign to the VM, in Mb/s.

- IO

The amount of throughput on the host's IO bus to assign to the VM, in Mb/s

Host Template Settings

Host templates describe models of physical hosts that you can deploy in the on-prem datacenter. As part of capacity planning, you might want to see how to replace your current hosts with different models. To do that, you create templates to represent the hosts you want, and then use those templates when running hardware replacement plans.

The host template is a collection of these settings:

- CPU

The processor for this host model. Note that CPU size and speed are not the only factors to determine processing power. To address this, you can specify the host CPU in the following ways:

- Select from Catalog



When you enable **Select from Catalog**, you can open up a catalog of CPU models that Turbonomic uses to map the model to an effective capacity for the CPU.

- Cores and CPU Speed



When you disable **Select from Catalog**, you can specify the number of **Cores** and the **CPU** clock speed – Turbonomic multiplies these values to calculate the host CPU resources.

- Memory

The amount of memory to allocate for the VM, in MB.

- Network

The host's network throughput, in MB/s.

- IO

The host's IO bus throughput, in MB/s

- Price

If you know the price of the host model that you're specifying for the template, you can enter it here. When running a plan, Turbonomic can use the price to calculate costs or savings when adding or removing host machines in an on-prem datacenter.

Selecting CPUs from the Catalog

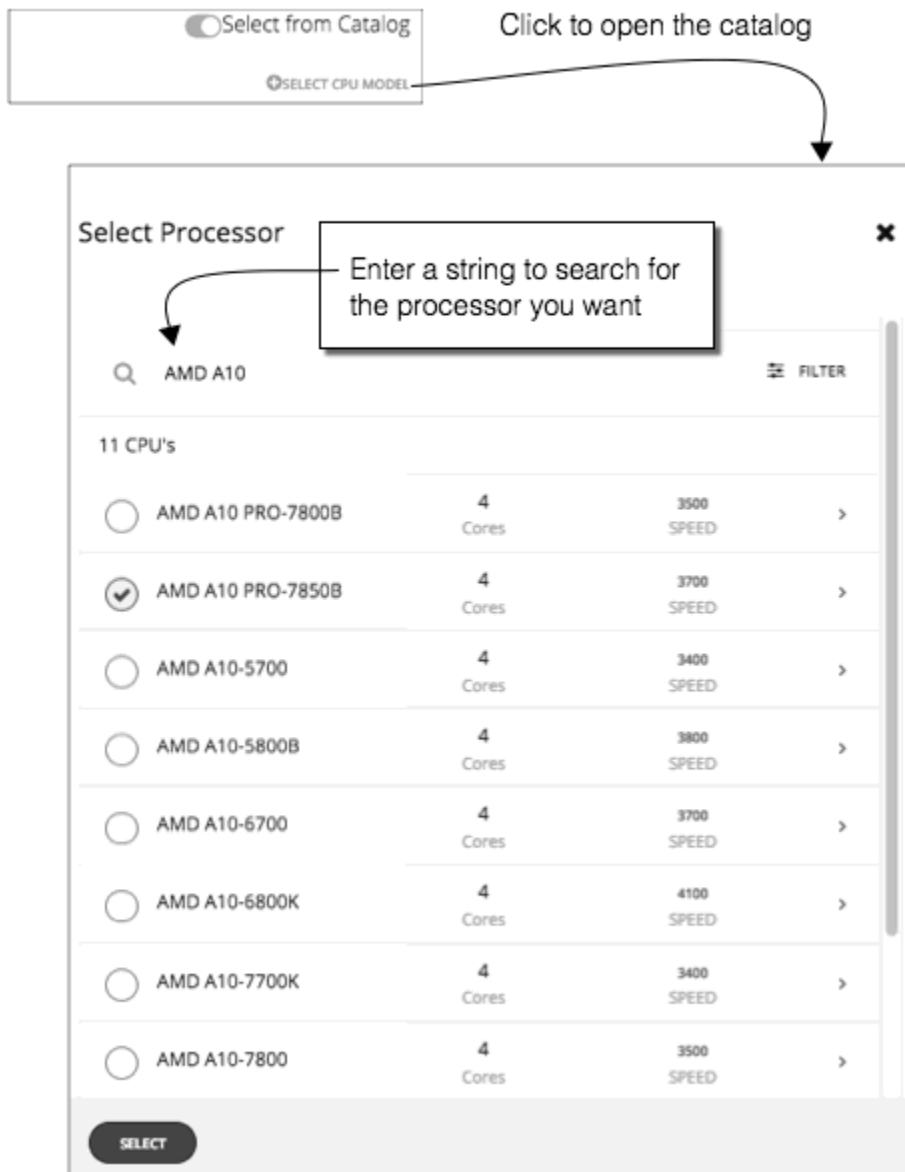
CPU processor speed is not necessarily an effective indicator of CPU capacity. For example, processor architecture can make a slower CPU have a greater effective capacity. Newer models of machines can often have fewer cores or less clock speed, but still have a higher effective capacity. This can affect planning in two ways:

- When planning hardware replacement, the plan knows the template's effective capacity. This means the plan knows how to best place workloads on the new hardware.
- For already deployed hosts, Turbonomic discovers the effective capacity and uses that information when calculating workload placement.

To build the catalog of CPU capacity, Turbonomic uses benchmark data from spec.org. When you set up the CPU for a host template, you can search this catalog for the processor you want, and set it to the template.

Note:

Turbonomic also uses the effective processor capacity when calculating workload placement in real-time. For more information, see [Effective CPU Capacity](#).



HCI Host Template Settings

HCI host templates describe models of physical hosts that support participation in a vSAN. Along with the host compute specifications, you also include specifications for storage capacity and redundancy (RAID level and failover). You can use these templates to plan for changes to your vSAN capacity.

Note:

For Hyper-V environments, if you run a Hardware Replace plan that replaces hosts with HCI Host templates, the results can be inconsistent or the plan can fail to place all the VMs in the plan scope. This typically occurs when Turbonomic detects a configuration issue with VMM or Hyper-V. As a result, Turbonomic treats the VMs as not controllable and will not attempt to place them.

The HCI Host template is a collection of these settings:

- CPU

The processor for this host model. Note that CPU size and speed are not the only factors to determine processing power. To address this, you can specify the host CPU in the following ways:

- Select from Catalog



When you enable **Select from Catalog**, you can open up a catalog of CPU models that Turbonomic uses to map the model to an effective capacity for the CPU.

- Cores and CPU Speed



When you disable **Select from Catalog**, you can specify the number of **Cores** and the **CPU** clock speed – Turbonomic multiplies these values to calculate the host CPU resources.

- Memory

The amount of memory to allocate for the VM, in MB.

- Network

The host's network throughput, in MB/s.

- IO

The host's IO bus throughput, in MB/s

- Storage

The capacity for this storage.

- **IOPS** – The effective IOPS capacity.

- **Size** – Raw storage capacity, in GB. A plan that uses this template will compute the effective storage capacity.

- Redundancy

The redundancy method for this storage on the virtualized SAN. This combines the RAID level and the number of host failures to tolerate.

- Price

If you know the price of the host model that you're specifying for the template, you can enter it here. When running a plan, Turbonomic can use the price to calculate costs or savings when adding or removing host machines in an on-prem datacenter.

Selecting CPUs from the Catalog

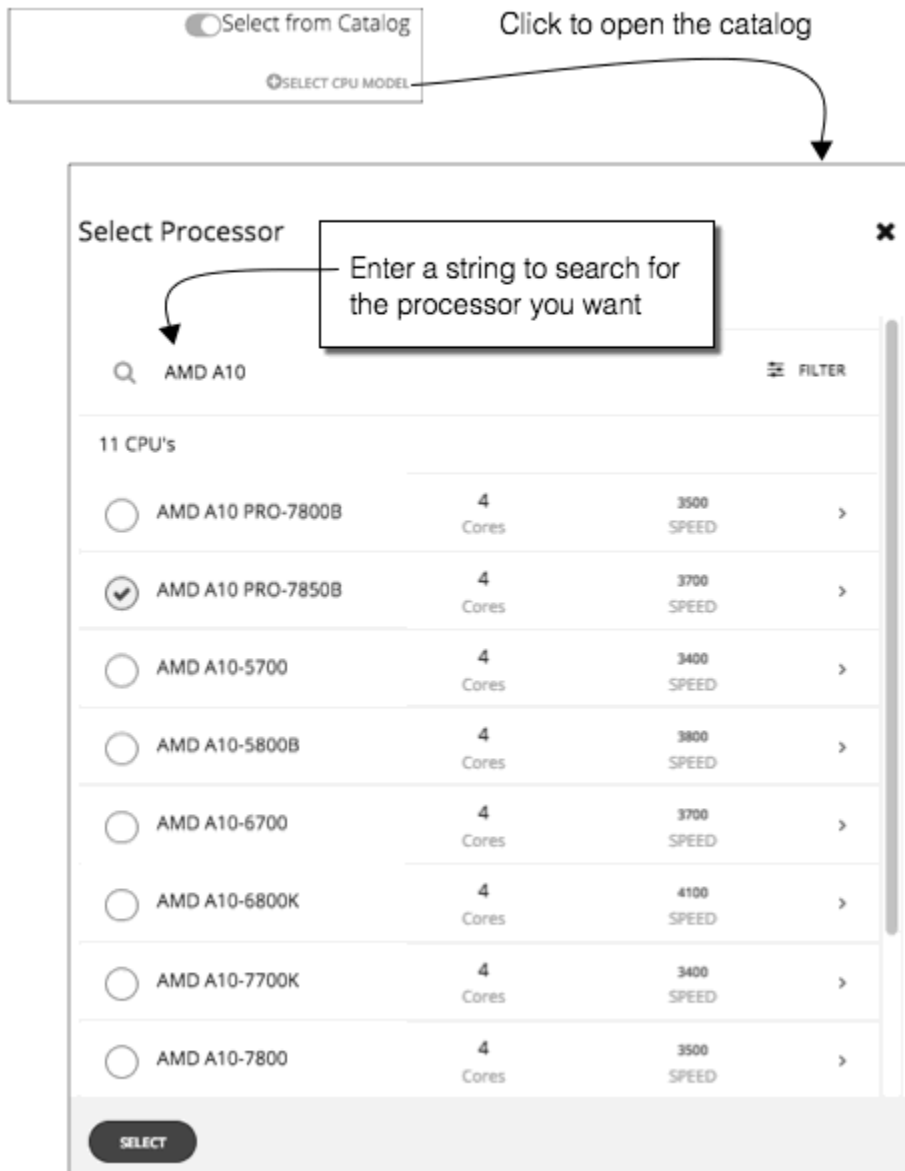
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- When planning hardware replacement, the plan knows the template's effective capacity. This means the plan knows how to best place workloads on the new hardware.
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To build the catalog of CPU capacity, Turbonomic uses benchmark data from spec.org. When you set up the CPU for a host template, you can search this catalog for the processor you want, and set it to the template.

Note:

Turbonomic also uses the effective processor capacity when calculating workload placement in real-time. For more information, see [Effective CPU Capacity](#).



Storage Template Settings

Storage templates describe models of storage that you can deploy in the on-prem datacenter. As part of capacity planning, you might want to see how to replace your current storage with different models. To do that, you create templates to represent the storage you want, and then use those templates when running hardware replacement plans.

The storage template is a collection of these settings:

- Storage
 - The capacity for this storage.
 - **IOPS** – The capacity for IO operations on this storage.
 - **Size** – The amount of storage capacity, in GB.
- Price

If you know the price of the storage model that you're specifying for the template, you can enter it here. When running a plan, Turbonomic can use the price to calculate costs or savings when adding or removing storage in an on-prem datacenter.

Billing and Costs

As you work with Turbonomic, you can set up costs that Turbonomic uses in its calculations. This setup includes:

- Reserved Instance Settings

To recommend placing workloads on Reserved Instances (RIs), Turbonomic uses the real pricing plans that are available to the targets public cloud accounts. Setting up an RI Purchase Profile adds even more detail to the pricing structure that Turbonomic uses in its calculations.

- OS Migration Profiles

For Migrate to Cloud plans, Turbonomic calculates the best placement for workloads that you want to move onto the public cloud. The migration includes choosing the OS for each migrated VM. The OS Profile that you configure here configures the default for how to manage the OS choices in migration plans.

- Price Adjustment

Cloud service providers can offer their own price lists, including special costs for services or discounts for workloads. However, Turbonomic does not discover these adjustments. For example, to reflect any discounted prices in the Turbonomic display and in Turbonomic analysis, you must manually configure those discounts. In Turbonomic, you configure such discounts via **Price Adjustments** for specific billing groups in your cloud environment.

RI Purchase Profile

The screenshot displays the 'RI Purchase Profile' configuration interface. It is divided into two main sections: 'AWS PROFILE' and 'AZURE PROFILE'. Each section contains radio button options for 'OFFERING CLASS', 'TERM', and 'PAYMENT'. In the AWS section, 'Standard' is selected for offering class, '1 Year' for term, and 'All Upfront' for payment. In the Azure section, '1 Year' is selected for term. At the bottom right, there are two buttons: 'RESET DEFAULTS' and 'APPLY SETTINGS'.

Profile	Setting	Selected Option	Other Options
AWS PROFILE	OFFERING CLASS	Standard	Convertible
	TERM	1 Year	3 Year
	PAYMENT	All Upfront	Partial Upfront, No Upfront
AZURE PROFILE	TERM	1 Year	3 Year

To recommend placing workloads on Reserved Instances (RIs), Turbonomic uses the real pricing plans that are available to the targets public cloud accounts. Setting up an RI Purchase Profile adds even more detail to the pricing structure that Turbonomic uses in its calculations.

The RI Purchase Profile determines the costs that Turbonomic will use for all RI decisions in your environment. As it sees opportunities to move workloads to an RI term, Turbonomic determines the costs

based on the purchase profile, and includes the cost information in action descriptions. Turbonomic also uses this information to calculate projected changes in cost, and to calculate costs for plan results.

Note that the settings you make here globally affect all of your public cloud environment.

To set up the RI Purchase Profile, navigate to **Settings > Billing and Costs**, and display the **RESERVED INSTANCE SETTINGS** tab. Then make the settings for your purchase profile:

- OFFERING CLASS

For AWS environments, choose the offering class that corresponds to the RI types that you typically use in your environment.

- TERM

For AWS and Azure environments, choose the payment terms you contract for your RIs. TERM can be one of **1 Year** or **3 Year**. Typically, longer term payment plans cost less per year.

- PAYMENT

The payment option that you prefer for your AWS RIs:

- All Upfront – You make full payment at the start of the RI term.
- Partial Upfront – You make a portion of the payment at the start of the term, with the remain cost paid at an hourly rate.
- No Upfront – You pay for the RIs at an hourly rate, for the duration of the term.

When you are satisfied with your RI Purchase Profile settings, click **APPLY SETTINGS**. Or to reset the form, click **RESET DEFAULTS**.

OS Migration Profile

For Migrate to Cloud plans, Turbonomic calculates the best placement for workloads that you want to move onto the public cloud. The migration includes choosing the OS for each migrated VM. The OS Profile that you configure here configures the default for how to manage the OS choices in migration plans.

To set up the OS Profile that plans will use by default, navigate to **Settings > Billing and Costs**, and display the **OS MIGRATION PROFILE** tab. Then make the settings for your OS profile:

<
Licensing

☐
Include OS cost
The plan includes OS cost per VM as part of the migration.

☐
BYOL ("Bring your own license")
The plan does not include OS cost as part of the migration. Use this option if you have purchased Azure Hybrid Benefit.

☒
Custom OS
The plan includes OS cost based on your selections.

SOURCE OS	TARGET OS	BYOL
Linux	Linux ▼	<input checked="" type="checkbox"/>
RHEL	RHEL ▼	<input checked="" type="checkbox"/>
SLES	SLES ▼	<input checked="" type="checkbox"/>
Windows	Windows ▼	<input checked="" type="checkbox"/>

The OS Migration Profile determines how Turbonomic will map the OS of each workload as it places that workload on the cloud destination. This includes how to choose VM templates that provide the OS you want, and whether to include the license cost in the Migrate to Cloud plan results. To configure an OS Migration Profile, choose from:

- Include OS cost

As Turbonomic calculates placement for the migrated workloads, it will include costs for instances that provide the same OS that the VM already has.
- BYOL (Bring your own license)

This is the same as the **Include OS cost** option, except the plan does not include OS licensing costs in any of the cost calculations for on-cloud placement.
- Custom OS

For each of the listed OS types, map the migrated VM to the OS you choose. The OS types are:

 - Linux – Any open source distribution of Linux. For the migration, Turbonomic will choose instances that provide the Linux platform that the cloud service provider delivers as a free platform. Note that this is always BYOL, because it assumes a free OS license.
 - RHEL (Red Hat Enterprise Linux)
 - SLES (SUSE Linux Enterprise Server)
 - Windows

If you enable **BYOL** for RHEL, SLES, or Windows, Turbonomic assumes that you are paying for the OS license, and will not include the license cost in the plan results. If you do not enable **BYOL**, Turbonomic gets the license cost from the service provider and includes that cost in the plan results.

When you are satisfied with your changes, click **APPLY SETTINGS**. Or to reset the form, click **RESET DEFAULTS**.

Price Adjustments

Cloud service providers can offer their own price lists, including special costs for services or discounts for workloads. However, Turbonomic does not discover these adjustments. For example, to reflect any discounted prices in the Turbonomic display and in Turbonomic analysis, you must manually configure those discounts. In Turbonomic, you configure such discounts via **Price Adjustments** for specific billing groups in your cloud environment.

Turbonomic applies these price adjustments to:

- Costs for workload template families, including:
 - Compute
 - RI Compute
- Costs for services, including:
 - Azure Active Directory
 - Azure Stack
 - Bandwidth
 - VM Licenses
 - AWS CloudWatch
 - AWS DynamoDB
 - And others

Note that in AWS environments, Turbonomic does not apply any discounts or other price adjustments to Spot Compute costs.

The general steps to configure a price adjustment are:

- Create the price adjustment:
 - Specify the adjustment scope

To do this, you choose which cloud service provider is giving you the adjustment, and then choose a billing group to set the scope of the adjustment.
 - Choose the Type

The price adjustment can be a Discount or an Increase. In most cases you will specify discounts for the price adjustment. While this sets the type for the overall adjustment, you can override the type for specific line items.
 - Specify a Price Adjustment setting

The Price Adjustment is the overall adjustment that your cloud service provider offers for the billing groups in your current scope. For example, AWS might offer you a 10% discount for a given account. For that billing group, you would specify a 10% Discount for the Price Adjustment setting.
- Specify Price Overrides (AWS only)

While your service provider might offer a general price adjustment for the billing group you chose, it might also offer further discounts for select services or template families. Or it might offer discounts for some template families, but price increases for some other services. You can configure these differences as Price Overrides.

Note:

Turbonomic uses the adjustments that you configure to display costs in the user interface. However, the values for hourly cost per entity, total hourly cost, total monthly cost, or total yearly cost can show inaccuracies on the order of a fraction of a percent. This is due to rounding when calculating the adjusted cost per entity.

Creating a Price Adjustment

A price adjustment configures adjusted workload pricing that you have negotiated with your Cloud Provider. After you configure an adjustment, Turbonomic applies it to pricing in the affected cloud scope.

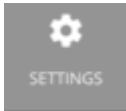
To create a price adjustment in Turbonomic, you identify the adjustment's scope – the subscriptions or billing families the adjustment applies to – and then set the type and percentage for the price adjustment. This specifies an overall adjustment for the workloads that fall within the billing group. For AWS, you can later drill into the adjustment to specify overrides for specific template families or services.

Notes:

- To use a price adjustment with a given billing group, you must increase the memory allocated to the VM that hosts your Turbonomic instance. The *Turbonomic Installation Guide* recommends that you provide a minimum of 16 GB when you install the product. To use price adjustments, IBM recommends that you increase the allocated memory as follows:
 - For the first price adjustment assigned to one or more billing groups, increase by 4 GB.
 - For each subsequent price adjustment assigned to one or more billing groups, increase by an additional 1 GB.
- Whenever you add, edit, or remove a Price Adjustment that is in use, you must allow sufficient time for Turbonomic to fully discover all of the affected environment, and to propagate the changes throughout that environment. In an average environment, this can take up to 30 minutes. As an alternative, you can manually execute rediscovery for the affected cloud subscription or account.

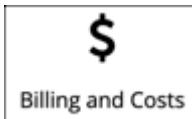
To create a price adjustment:

1. Navigate to the Settings Page.



Click to navigate to the Settings Page. From there, you can perform a variety of configuration tasks.

2. Choose Billing and Costs.



Click to navigate to the Billing and Costs page.

3. Display the PRICE ADJUSTMENT tab.

Click the **PRICE ADJUSTMENT** tab to see all of the adjustments that have been configured for your environment. In this list you can:

- Click an entry to see details and edit the adjustment
- Select an entry to delete the adjustment
- Create new price adjustments

4. Create the price adjustment.

The image shows a 'NEW PRICE ADJUSTMENT' button at the top left. Below it is a modal dialog titled 'Add New Price Adjustment' with a close button (X) in the top right corner. The dialog contains the following fields and options:

- NAME:** A text input field.
- BILLING GROUPS:** A dropdown menu showing 'AWS Billing Family / Azure Subsc' with a right-pointing arrow.
- TYPE:** A dropdown menu showing 'Discount' with up and down arrows.
- PRICE ADJUSTMENT:** A text input field with a '%' symbol at the end.
- PRICE OVERRIDES:** A link with a plus icon and the text 'PRICE OVERRIDES'.
- SAVE:** A button at the bottom right.

Annotations with arrows point to the following elements:

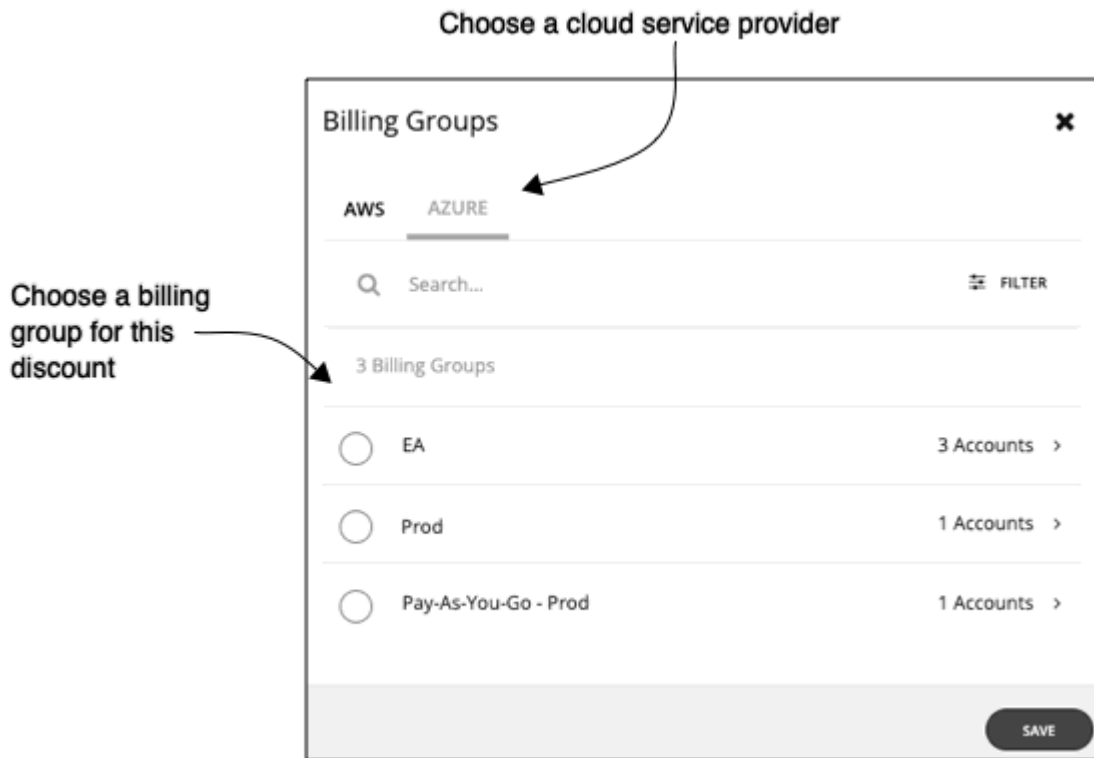
- 'Give the adjustment a name' points to the NAME field.
- 'Choose Billing Groups to set the adjustment scope' points to the BILLING GROUPS dropdown.
- 'Set the Type to Discount or Increase' points to the TYPE dropdown.
- 'Set the percentage for the global adjustment' points to the PRICE ADJUSTMENT field.
- 'Drill down to override the adjustments for subsets within the overall scope' points to the PRICE OVERRIDES link.

First click **NEW PRICE ADJUSTMENT**, then specify the following settings to configure a price adjustment:

- Give the adjustment a name.
- To set the scope for this adjustment, choose its Billing Groups.

Click in the **BILLING GROUPS** field to display the Billing Groups fly-out.

In the Billing Groups fly-out, choose the cloud service provider you want to work with and then choose the billing group for the scope of this adjustment.



A Billing Group is a set of cloud service provider accounts that are consolidated into a single billing schedule. Billing group details depend on your service provider:

- Azure: For Azure environments, Turbonomic lists each Azure subscription as a billing group.
- AWS: To consolidate billing, AWS supports billing families of AWS accounts, where there is a *master* account and other *member* accounts. Turbonomic lists each billing family as a billing group. You can choose a billing family to set the scope of this adjustment.

After you have chosen your billing group, click **SAVE** to return to the Add New Price Adjustment fly-out.

- Set the Type for this price adjustment – Choose either **Discount** or **Increase**.
- Specify a percentage of adjustment as the Price Adjustment.

Enter the percentage in the **PRICE ADJUSTMENT** field. The acceptable value depends on the type of adjustment:

- For a discount: 0 - 99.99%
- For an increase: 0 - 999.99%

This is the general percentage of adjustment (increase or discount) for the current scope. For any costs within the adjustment scope, Turbonomic will apply this percentage as it calculates the optimal workload capacity and placement.

Note:

If you set an overall adjustment of 0%, then Turbonomic enforces a Type setting of Discount. The end result is the same, because an increase or a discount of 0% is the same.

5. (AWS only) Specify any price overrides for this price adjustment.

Add New Price Adjustment

NAME

My Azure Discount

BILLING GROUPS

Prod

TYPE

Discount

PRICE ADJUSTMENT

10%

PRICE OVERRIDES

SAVE

Click PRICE OVERRIDES to add specific cost overrides

The PRICE ADJUSTMENT percentage you just specified applies as a default in the adjustment scope. However, you might have negotiated different prices for specific services or template families in your cloud environment. To configure these special prices, click **PRICE OVERRIDES** to open the Cloud Cost Adjustment fly-out.

For details, see [AWS Price Override](#).

6. Save your work.

After you have configured the price adjustment, click **SAVE**.

AWS Price Override

Cloud Cost Adjustment [AWS] - My AWS Discount

DOWNLOAD

SERVICES	TYPE	PRICE ADJUSTMENT %	OVERRIDE %	ORIGINAL RATE (LINUX)	EFFECTIVE ADJUSTMENT %	ADJUSTED RATE (LINUX)
AWS CloudTrail	Discount	10 %	%	—	10 %	—
AWS CloudWatch	Discount	10 %	%	—	10 %	—
AWS Developer Sup...	Discount	10 %	%	—	10 %	—
AWS DynamoDB	Discount	10 %	%	—	10 %	—
^ AWS EC2 Compute *	Discount	10 %	%	—	10 %	—
^ c5d *				—		—
^ c5d.9xlarge...	Discount	10 %	15 %	—	15 %	—
^ c5d.18xlarge	Discount	10 %	%	—	10 %	—

To override the PRICE ADJUSTMENT setting for AWS billing groups, Turbonomic analysis can use settings for different services that AWS provides to your accounts.

In AWS, you can set up a billing family that includes a *master* account and a given set of *member* accounts. Turbonomic treats the AWS billing family as a Billing Group. For more information about billing families and accounts, see [AWS Billing Families](#).

Assume you have configured a price adjustment with a discount of 10% for a billing family, to match the overall discount that AWS offers you for that scope. But then assume the account includes extra discounts for some of the services your billing families provide. Then you can create overrides to add the extra discounts to those services.

Turbonomic uses the adjusted costs in its analysis as it calculates actions. For example, assume a price adjustment of 10% for a billing group, and a discount of 20% for the M4.Large family of templates. As Turbonomic places a workload, it will consider both the template capacity and the template cost. Even if an M4 template is larger than the workload actually needs, the M4 template could be less expensive because of the added discount. In that case, Turbonomic will place the workload on the less expensive template.

Note:

The Cloud Cost Adjustment table lists the services that are available to you for the AWS billing family that you have set up as the discount scope. The services this table displays depend on whether the billing family uses the given service, and whether there is any recorded cost at the time that you display the table. For this reason, under some circumstances you might see different services listed in the table.

Under all circumstances, the table lists the services, AWS EC2 Compute, AWS EC2 Reserved Instance, and AWS RDS.

Also, for the Cloud Cost Adjustment table to display CSP Cost and Effective Cost, you must have created a Cost and Usage report in AWS, and you must store it in an S3 bucket.

Displaying AWS Spend In Turbonomic.

In the Cloud Cost Adjustment table, you can perform the following:

- Override the price adjustment for a service or template family.

To add an override, choose the line item for a service, or expand the row for a template family and:

- Set the Type. Double-click and then choose **Discount** or **Increase**. Press **Enter** to confirm your setting.
- Specify the percentage for this override, and then press **Enter** to confirm your override. The value you enter here is an absolute value for the discount or increase Turbonomic will apply for this line item.

When you're done setting these overrides, click **Save**.

- To remove all overrides and revert back to the PRICE ADJUSTMENT Discount, click **CLEAR ALL OVERRIDES**.
- To download a report of the discounts for each service, click **DOWNLOAD** and choose CSV or PDF.

The table lists the following information about your discounts:

- SERVICES

The different cloud services to which you can set an override discount. To see individual workload templates:

- For Azure, expand **Virtual Machines**
- For AWS, expand **AWS EC2 Compute** or **EC2 Reserved Instance**

- TYPE

Whether this price adjustment will be an increase or a discount. By default, this field shows the setting that you have made for the Price Adjustment. However, you can change it as an override for an individual entry.

- PRICE ADJUSTMENT %

The percentage that you have specified for the Price Adjustment setting. This is the general adjustment that Turbonomic applies by default to the given service.

- OVERRIDE %

If you have entered a value, this is the price adjustment Turbonomic applies to the given service.

- ORIGINAL RATE (LINUX)

The Cloud Service Provider's cost for VM templates, per hour. To see these costs, expand the workload services to show specific templates. The cost assumes no charge for the OS license, as though the VM runs Linux.

- EFFECTIVE ADJUSTMENT %

The actual adjustment for the given service.

- ADJUSTED RATE (LINUX)

The discounted cost for VM templates, per hour. To see these costs, expand **Virtual Machines** to show specific templates. The cost assumes no charge for the OS license, as though the VM runs Linux.

AWS Billing Families



As you configure AWS targets, Turbonomic discovers AWS accounts that are consolidated into *billing families*. A billing family has one *master* account, and zero or more *member* accounts. By recognizing billing families, Turbonomic more accurately calculates cloud investments and savings, and makes more accurate recommendations for RI coverage.

In the Targets user interface, master accounts appear in bold, with a star next to them. You can expand the account entry to see the related member accounts. If you expand the entry for a member account, then the related accounts includes the family master, indicated by a star.

For RI purchases, different accounts in a billing family can share the same RI resources. At the same time, accounts in other billing families cannot use those RIs. This adds flexibility to your RI coverage, while maintaining order over the billing.

In Turbonomic, if you enable Billing Family Recognition, then you can see the billing family master and member accounts in the Targets user interface, and Turbonomic can recommend proper RI purchases within the correct billing families.

To enable Billing Family Recognition, ensure the following as you configure your AWS targets:

- Use the proper role for each AWS target

To properly discover billing family information for a target, you must give Turbonomic credentials for an AWS role that includes the permission, `organizations:DescribeOrganization`. With that permission, Turbonomic can:

- Discover master accounts and member accounts in different billing families
- Display the account names in the user interface
- Discover billing information for each family and account
- Recommend RI actions that respect billing family boundaries

- Configure targets for the complete billing family

One billing family can consolidate a number of AWS accounts. For Turbonomic to include these accounts in its analysis, you must configure each one as a separate target. If you do not configure all the accounts in a billing family, then Turbonomic cannot discover complete billing information for that family, and its analysis will be based on incomplete information.

Turbonomic displays member accounts that have been configured as targets in regular text. For members that Turbonomic discovers but have not been configured as targets, Turbonomic displays their names in grayed text.

If you have enabled Billing Family Recognition, you should keep the following points in mind:

- Billing families can grow

Turbonomic regularly checks the membership of your billing families. If it discovers a new member account, it adds that account to the list of members. If you have already configured the account as a target, then Turbonomic includes the new member in its analysis of billing families. If the new member is not already a target, then Turbonomic lists the new member in grayed text.

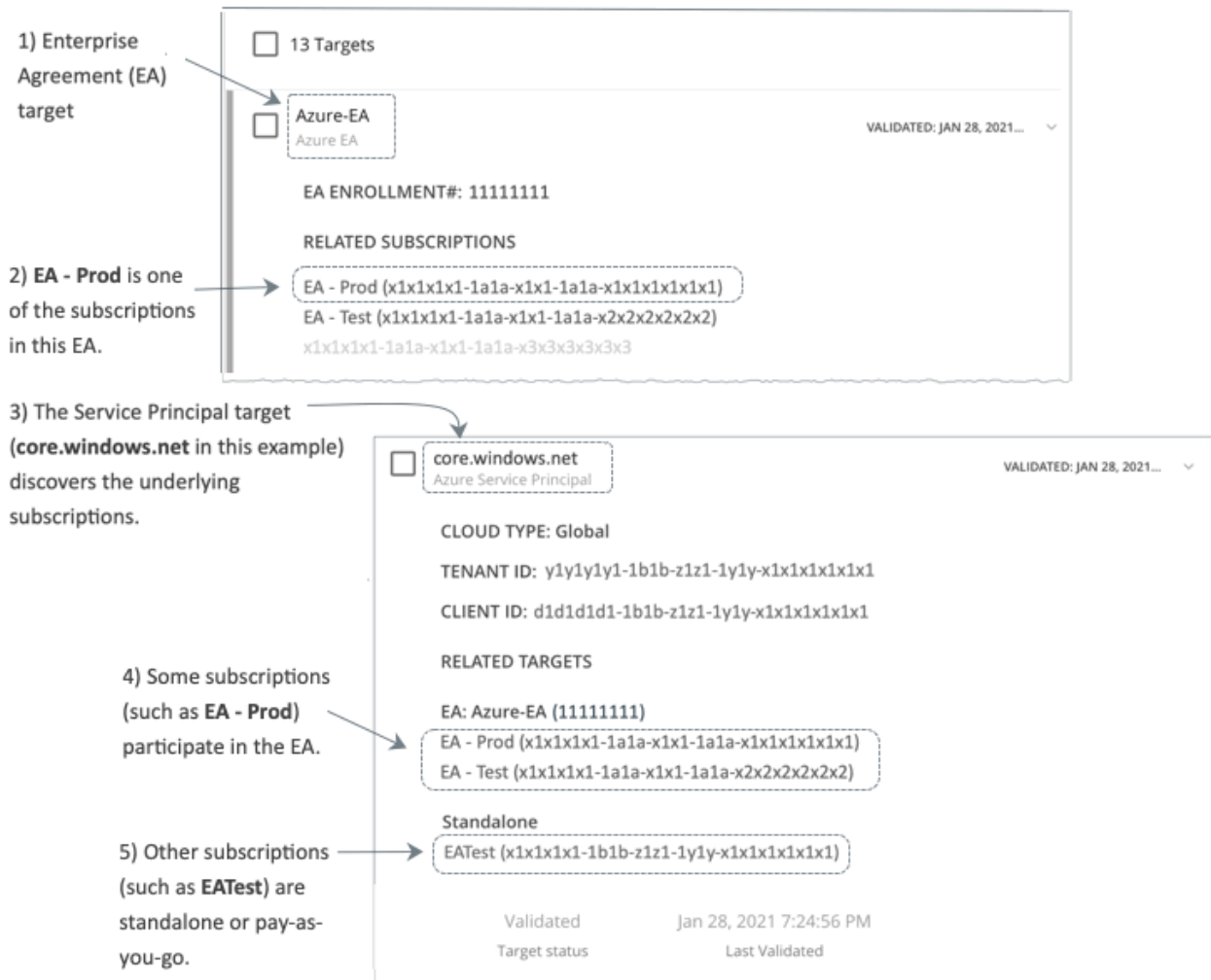
- You can configure discounts per billing family

Turbonomic includes a feature to set a discount for a billing group, and to override that discount for specific template families within that scope. For more information, see [Cloud Discounts](#) and [Discount Override: AWS](#).

- You might see master accounts that have no member accounts

AWS treats every account you create as a part of a billing family. Assume you created an account, but you had no reason to consolidate its billing with any other accounts. In that case, the account appears in the Turbonomic user interface as a master account, but it has no member accounts.

Azure Enterprise Agreements



You can configure Turbonomic to manage Azure subscriptions within the context of an Enterprise Agreement (EA). An EA defines specific pricing, including the pricing for Reserved Instances (RIs). When you configure an EA target, and set the EA key to your Azure targets, Turbonomic uses that richer pricing information to calculate workload placement and RI coverage for your Azure environment.

To enable Turbonomic management of Azure EA environments, you must configure:

- One Microsoft Enterprise Agreement target
- At least one Service Principal target that can discover the underlying Azure subscriptions

For information about Azure targets, see [Microsoft Azure](#).

In the Targets View, you can identify the targets related to Azure EA as follows:

- EA Targets

The target that discovers the EA to track pricing and RI information. You can have one EA target per Turbonomic deployment.

- Azure Subscription Targets

The targets that manage the workloads in your Azure environment. These are discovered by Service Principal targets. Note that not all subscription targets *necessarily* participate in the EA. Expand these entries to see the related Service Principal target. For members of the EA, you can see the related EA target as well.

Subscriptions that do not participate in the EA appear as Standalone targets.

Note:

In rare circumstances, you can have a subscription that is not in use – The subscription has no workloads associated with it. In this case, Turbonomic identifies the subscription as Standalone. This is because the target cannot discover any cost or usage information that would relate the subscription to its EA.

- Service Principal Targets

The Azure target that you configure to discover Azure subscription targets. Expand the entry to see the discovered targets. If you have configured an EA target, the entry lists that as well, along with the EA enrollment number.

Reserved Instances and Azure EA

For Azure environments, Turbonomic can only discover and use RIs if you have configured a Microsoft Enterprise Account target, and if one or more subscriptions participate in that EA.

To discover and manage RIs in Azure environments, Turbonomic uses both the EA target and the associated subscription targets. On its own, a subscription target exposes costs for pay-as-you-go pricing. The EA target discovers pricing for the available RI instance types. Turbonomic combines this information to track:

- RI utilization
- RI coverage
- Virtual machine costs (accounting for RIs)

Note:

This release of Turbonomic does not support RI discovery and management for Classic VMs and Classic Cloud Services. Also, it does not support RI discovery and management for Suppressed Core virtual machines.

Cost Calculations for Azure Environments

To understand the reported costs in your Azure environment, consider these points:

- For targets that participate in the EA, Turbonomic uses the terms of the given EA, and bases costs on the Offer ID that is effective for the given subscription.
- For VMs in Azure, RI pricing does not include the cost of the OS license. However pricing for on-demand VMs does include the license cost.

Note:

For Microsoft Azure EA environments, the projected cost for RI Purchase actions might not match associated costs you find in the Microsoft Pricing Calculator.

Turbonomic actions can recommend RI purchases. For these recommendations, the action assumes a free Linux OS, so the cost estimate does not include the OS cost. However, The Microsoft Pricing Calculator does include costs for OS licenses. As a result, when you compare the Turbonomic cost estimates to the values in the Pricing Calculator, it's likely that the two estimates will not match. This difference also affects the Break Even Point that appears in the Recommended RI Purchases chart. Because the recommended purchases do not include Azure costs for OS licenses, the listed Break Even Point can be optimistic.

- For workloads you migrated from on-prem to the Azure cloud, Turbonomic recognizes Azure Hybrid Benefit (AHUB) savings for RIs and on-demand workloads. The costs you see in Turbonomic charts include this benefit. However, remember that recommended actions do not include any license cost, so the actions will not reflect any proposed AHUB savings (see above).

Currency Settings

By default, Turbonomic uses the dollar symbol (\$) when displaying the costs and savings that it discovers or calculates for your cloud workloads. You can set a different symbol to match your preferred currency. For example, if your cloud provider bills you in euros, change the currency symbol to €. To do this, go to **Settings > Billing and Costs** and then click the **Currency** tab.

Turbonomic saves your preference in the local storage of the browser that you used to access the user interface. It reverts to the default symbol if you use another browser or view the user interface in incognito/private mode.

Currency symbols are for display purposes only. Turbonomic does not convert monetary amounts when you switch symbols.

Administrative Tasks

To perform Turbonomic administrative tasks, you will navigate to different pages from **Settings**. The different tasks you can perform for Turbonomic include:

- [Managing User Accounts](#)

Create and manage user accounts for Turbonomic.

- [Viewing the Update page](#)

See information about your current version.

- [License Configuration](#)

Review the status of your current license, and apply any license upgrades.

Managing User Accounts

As an administrator, you specify accounts that grant users specific access to Turbonomic. User accounts determine the following for a given user login:

- User Authentication

To configure an account, you set the type of authentication the account will use:

- Local User – Configure the username and password and save those credentials on the Turbonomic server.
- External User – Single user accounts that authenticate through Single Sign-on (SSO) or through Microsoft Active Directory (AD).
- External Group – A group of user accounts that authenticate through SSO or AD.

- User Authorization

Properties that determine the range of access and features for a given user:

- Role – Access to specific Turbonomic features
- Scope – How much of the environment this user can manage

As you configure user accounts, you can set up access to specific clusters in your environment. You can even set up accounts for tenant customers, and only show them the virtual workloads they own in their specific virtual datacenters.

Important:

You can configure Turbonomic to use SSO authentication. When SSO is enabled, Turbonomic only permits logins via the SSO IdP. Whenever you navigate to your Turbonomic installation, it redirects you to the SSO Identity Provider (IdP) for authentication before displaying the Turbonomic user interface.

Before you enable SSO for your Turbonomic installation, *you must configure at least one SSO user with Turbonomic administrator privileges*. If you do not, then once you enable SSO you will not be able to

configure any SSO users in Turbonomic. To authorize an SSO user as an administrator, use **EXTERNAL AUTHENTICATION** to do one of the following:

- Configure a single SSO user with administrator authorization.

Add an external user. The username must match an account that is managed by the IdP.

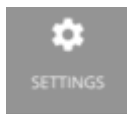
- Configure an SSO user group with administrator authorization.

Add an external group. The group name must match a user group on the IdP, and that group must have at least one member.

For information about configuring SSO user groups in SAML, see [Configuring a Group for SSO Authentication](#). For information about configuring SSO authentication for Turbonomic, see "Single Sign-On Authentication" in the *Turbonomic Installation Guide*.

To work with Turbonomic accounts:

1. Navigate to the Settings Page.



Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. Choose User Management.



User Management

Click to navigate to the User Management Page.

Manage local or external authentication

ALL SETTINGS / USER MANAGEMENT

User Management

LOCAL USERS EXTERNAL AUTHENTICATION

NEW LOCAL USER

All Local Users

- Administrator - 1
- administrator - 1
- Advisor - 1
- Automator - 2
- Site Administrator - 2
- Deployer - 1

Search... FILTER

8 Users

- ☐ administrator
- ☐ Alice
- ☐ Bob

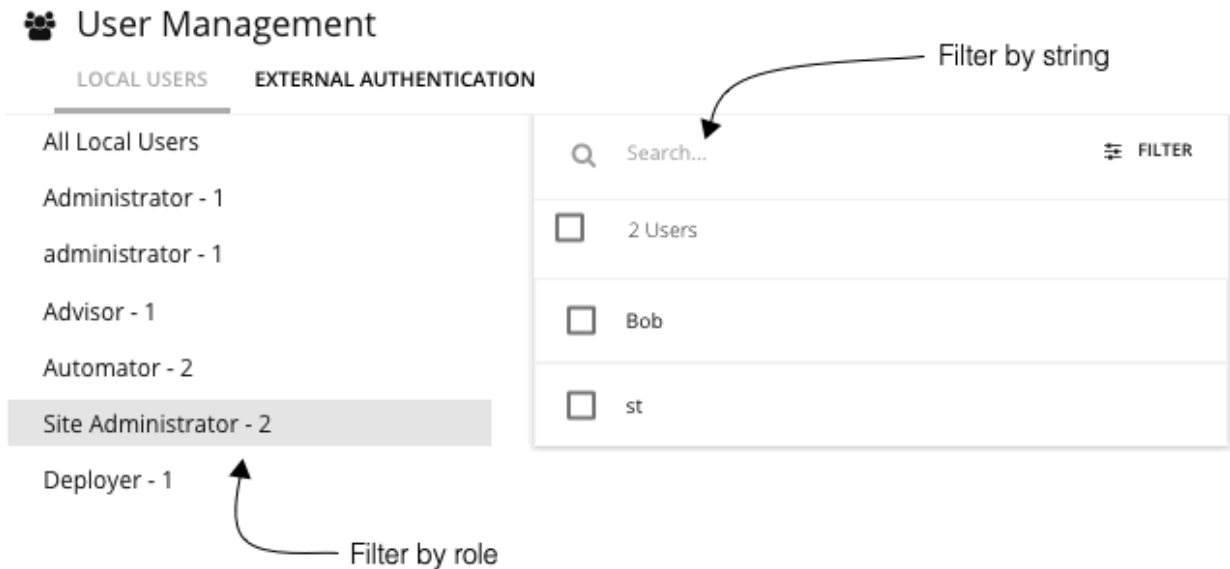
List of accounts

Click a name to edit the account
Select an account to delete it.

This page lists all the user accounts that you currently have configured for Turbonomic. You can:

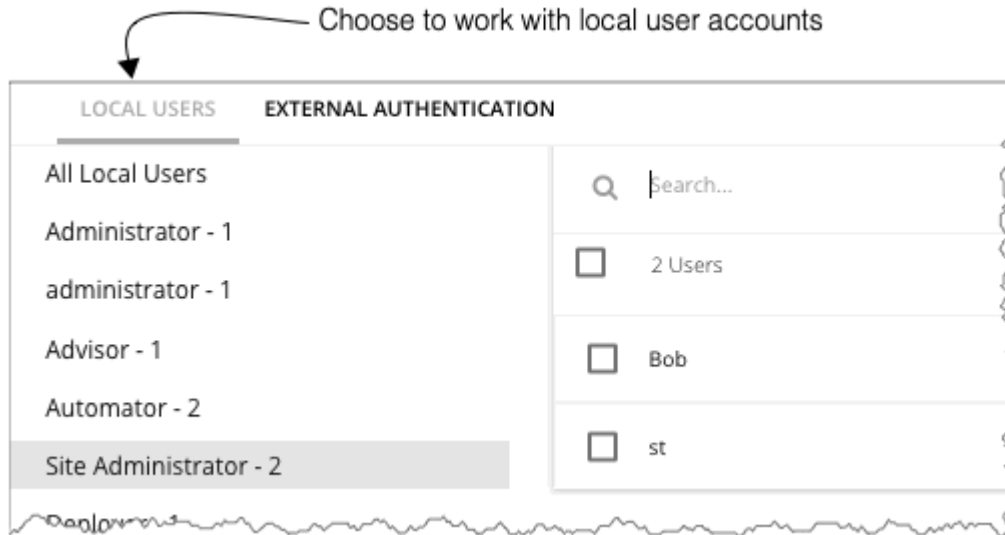
- Click to manage LOCAL USERS or EXTERNAL AUTHENTICATION
- Select an entry to delete the account
- Click a name to edit the account

- Create new user or group account
 - Configure Active Directory settings
3. Filter the list of users.



To work with a long list of users, you can filter by role (for example, only show administrator or only show observer users). You can also type a string in the **Search** field to filter the list, and you can sort the list by name.

4. Work with Local user accounts.



Turbonomic stores local accounts and their credentials on the Turbonomic platform. Local authentication is for individual users, only.

When you choose **LOCAL USERS**, Turbonomic displays a list of all the local user accounts you have configured for this installation.

5. Create or edit a local user account.

The diagram shows a 'New Local User' fly-out panel with the following fields and annotations:

- NEW LOCAL USER** button: Click to open the **New Local User** fly-out panel
- USERNAME *** text input: Provide the account credentials
- PASSWORD *** password input: Provide the account credentials
- ROLE** dropdown menu: Choose the account role from the list
- SCOPE (OPTIONAL)** section: You can limit this account to a given scope in your environment
 - TestCluster X
 - + ADD SCOPE
- USER PERMISSIONS** section: The user permissions are different for each role
 - Can use all of the Turbonomic features including Plan and Place, but cannot configure the Turbonomic installation.
- SAVE USER** button: When you are done, save the account

To add a new local user, click **NEW LOCAL USER**. To edit an existing account, click the account name in the list. To configure a local account, specify:

- Authentication:
 - Provide the username and password. Turbonomic stores these credentials on the local server.
- Authorization – User Role:
 - Administrator
 - Can use all Turbonomic features, and can modify settings to configure the Turbonomic installation.
 - Site Administrator
 - Can use all Turbonomic features, and can modify site-specific settings to configure the Turbonomic installation. Can administer Groups, Policies, Templates, Billing/Costs, Users (cannot create users with Administrator role), Target Configuration, but cannot administer Email, Licenses, Updates, and Maintenance.
 - Automator
 - Can use all of the Turbonomic features including Plan and Place, but cannot configure the Turbonomic installation or create policies.
 - Deployer

Can view all Turbonomic charts and data, can use Place to reserve workloads, and can create placement policies and templates. However, this role cannot run plans or execute any recommended actions.

- Advisor

Can view all Turbonomic charts and data, and can run plans, but cannot use Place to reserve workloads, or execute any recommended actions.

- Observer

Can view the environment, including the Home Page, and Dashboards. Can also use Search to set a scope to the session. For scope, only VM groups and Resource Groups are supported.

- Operational Observer

Can view the environment, including the Home Page, Dashboards, Groups, and Policies. Can also use Search to set a scope to the session.

- Shared Advisor

A scoped user. Can only see VMs and Applications, and cannot execute Turbonomic actions. Can view the Home Page and Dashboards.

- Shared Observer

A scoped user. Can only see VMs and Applications, and cannot execute Turbonomic actions. Can view the Home Page and custom Dashboards, but not Executive Dashboards. This is the most restricted user.

- Report Editor

Can create, edit, and delete reports. If you have a Grafana Enterprise license, can also schedule the e-mailing of reports. Due to limits to the reporting license, only one user per instance is allowed to have this role (by default, the local **administrator** user). To assign this role to another user, you must first remove it from the current user. Be sure that the new user is *not* a scoped user.

- Authorization – Scope (optional)

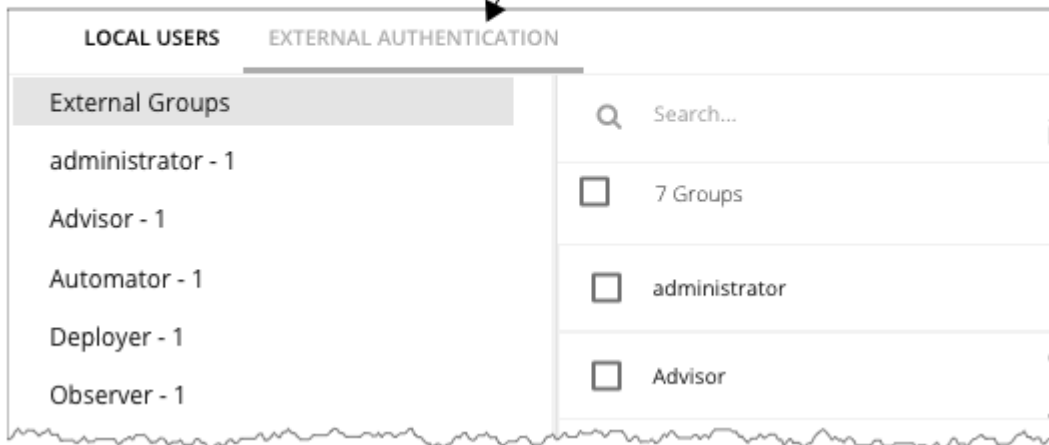
The scope limits what the user can monitor. For example, you can scope to a group that contains only the physical machines that support this user's VMs or applications. Click **ADD SCOPE** and choose which groups or clusters this user can see.

Note:

Under most circumstances, a scoped user cannot see actions for entities that are outside of the configured scope. However, when zooming in to Host entities, the user can see actions for storage that is outside of the user's scope if the hosts use that storage.

6. Work with EXTERNAL AUTHENTICATION to set up SSO or AD accounts.

Choose to work with externally authenticated users or groups



For External Authentication, you configure Turbonomic to use SSO or AD services to manage the credentials and authentication of users. You can create external accounts to authorize user groups or individual users.

Note:

If a user is a member of multiple groups, then Turbonomic logs the user on via the first SSO or AD that successfully authenticates the user. Also note that Turbonomic does not support nested AD groups – AD logins must be for users in a top-level group.

To enable SSO, you must configure access to the given IdP. For information about configuring SSO, see "Single Sign-On Authentication" in the *Turbonomic Installation Guide*.

To enable AD you must specify either an AD domain, an AD server, or both. Turbonomic uses this connection for all AD users.

7. Enable AD authentication.

EDIT AD

You must specify or edit the AD connection

Edit Active Directory ✕

ACTIVE DIRECTORY DOMAIN

corp.com

ACTIVE DIRECTORY SERVER

ldaps://corp.com:636

☒ Secure

SAVE ACTIVE DIRECTORY

To enable AD, click **CONNECT TO AD** and configure:

- Active Directory Domain – To authenticate AD groups, specify a domain so that AD can find a given user via the User Principal Name (UPN). If you specify a domain, but not a server, authentication uses any AD server from that domain.
- Active Directory Server – To disable AD groups, specify a server but do not specify a domain. If you specify a domain and a server, authentication will use that server, and will also support groups.

When you configure an AD server, by default Turbonomic assumes the AD server port to be 389 or 636. To specify a custom port for the AD server, add the port number to the AD server IP address. For example, 10.10.10.123:444 sets port 444.

- Secure – Use a secure connection when communicating with AD servers. Note that the AD domain must be configured to use LDAPS, and you must have imported a certificate into the Turbonomic server.

Turbonomic can support LDAP channel binding and LDAP signing. To support these Active Directory features, you must configure secure access.

For more information, see "Enforcing Secure Access" in the *Turbonomic Installation Guide*.

8. Create or edit an SSO or AD account.

Click to open the **New External User** or **New External Group** fly-out panel

Provide a valid name for the SSO or AD user

Choose the account role from the list

The user permissions are different for each role

When you are done, save the account

NEW EXTERNAL USER

NEW EXTERNAL GROUP

New External User ✕

USERNAME *

john@corp.mycompany.com

ROLE

Site Administrator ▼

USER PERMISSIONS

Can use all Turbonomic features, and can modify site-specific settings to configure the Turbonomic installation. Can administer Groups, Policies, Templates, Billing/Costs, Users (cannot create users with Administrator role), Target Configuration, but cannot administer Email, Licenses, Updates, and Maintenance

SAVE USER

This account can be for a user group or for a single user. To add a new account, click **NEW EXTERNAL GROUP** or **NEW EXTERNAL USER**. To edit an existing account, click the account name. To configure an external account, specify:

- Authentication:

Provide the group or user name for this account. The name you provide must meet certain requirements, depending on the type of account you are creating:

- **External Group - SSO**

Provide a name that matches a group the IdP manages.

- **External Group - AD**

The group name must match a group that is accessible from the domain and servers that you configured in **EDIT AD**.

- **External User - SSO**

Provide a user name that matches a user managed by the IdP.

- **External User - AD**

The username must be a valid User Principal Name (UPN). For example, john@corp.mycompany.com.

- Authorization – User Role:

- Administrator

Can use all Turbonomic features, and can modify settings to configure the Turbonomic installation.

- Site Administrator

Can use all Turbonomic features, and can modify site-specific settings to configure the Turbonomic installation. Can administer Groups, Policies, Templates, Billing/Costs, Users (cannot create users with Administrator role), Target Configuration, but cannot administer Email, Licenses, Updates, and Maintenance.

- Automator

Can use all of the Turbonomic features including Plan and Place, but cannot configure the Turbonomic installation or create policies.

- Deployer

Can view all Turbonomic charts and data, can use Place to reserve workloads, and can create policies and templates. However, this role cannot run plans or execute any recommended actions.

- Advisor

Can view all Turbonomic charts and data, and can run plans, but cannot use Place to reserve workloads, or execute any recommended actions.

- Observer

Can view the environment, including the Home Page, Dashboards, and Groups (VM Groups and Resource Groups only). Can also use Search to set a scope to the session. For scope, only VM groups and Resource Groups are supported.

- Operational Observer

Can view the environment, including the Home Page, Dashboards, Groups, and Policies. Can also use Search to set a scope to the session.

- Shared Advisor

A scoped user. Can only see VMs and Applications, and cannot execute Turbonomic actions. Can view the Home Page and Dashboards.

- Shared Observer

A scoped user. Can only see VMs and Applications, and cannot execute Turbonomic actions. Can view the Home Page and custom Dashboards, but not Executive Dashboards. This is the most restricted user.

- Report Editor

Can create, edit, and delete reports. If you have a Grafana Enterprise license, can also schedule the e-mailing of reports. Due to limits to the reporting license, only one user per instance is allowed to have this role (by default, the local **administrator** user). To assign this role to another user, you must first remove it from the current user. Be sure that the new user is *not* a scoped user.

- Authorization – Scope (optional)

The scope limits what members of this group can monitor. For example, you can scope for access to only the hosts that support this group's VMs or applications. Click **DEFINE SCOPE** and choose which entities this members of this group can see.

Configuring a Group for SSO Authentication

To use SSO authentication in Turbonomic, you should configure user groups on the IdP. The IdP can authenticate the group members, and then Turbonomic can assign the user role and scope according to that group's authentication. To manage personnel changes, you only need to manage the membership in the IdP group. For example, if a user leaves your organization, you only need to remove the member from the group on the IdP. Because authorization on Turbonomic is by group, that user will not have any authorization settings stored on the Turbonomic server.

Important:

Before you enable SSO for your Turbonomic installation, *you must configure at least one SSO user with Turbonomic administrator privileges*. If you do not, then once you enable SSO you will not be able to configure any SSO users in Turbonomic. To authorize an SSO user as an administrator, use **EXTERNAL AUTHENTICATION** to do one of the following:

- Configure a single SSO user with administrator authorization.

Add an external user. The username must match an account that is managed by the IdP.

- Configure an SSO user group with administrator authorization.

Add an external group. The group name must match a user group on the IdP, and that group must have at least one member.

For more information about configuring SSO authentication, see "Single Sign-On Authentication" in the *Turbonomic Installation Guide*.

Specifying a Group in the SAML Response

To support SSO, Turbonomic recognizes IdP responses that comply with SAML 2.0. To create user groups, for each user response you include an attribute named group, and give the group name as the attribute value. For example, assuming the following users, setting the group attribute for each user assigns that user to the appropriate group.

Users:	Group Attribute:
<ul style="list-style-type: none">• George• Paul• John• Ringo	Attribute Name=group, AttributeValue=Beatles
<ul style="list-style-type: none">• Smokey• Pete• Ronnie• Claudette• Bobby• Marv	Attribute Name=group, AttributeValue=Miracles

As you specify the user response, to add the user to a group you include a group attribute. For example, to add a user to a group named turbo_admin_group, you would include the following attribute in that user's SAML response:

```
<saml2:Attribute
  Name="group"
  NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:unspecified">
  <saml2:AttributeValue
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:type="xs:string">
    turbo_admin_group
  </saml2:AttributeValue>
</saml2:Attribute>
```

Setting Group Authorization in Turbonomic

To set an account role and scope to a user group, you must use the group name that you specify as the value in the given SAML group attribute. In the above example, the group value is turbo_admin_group. To set authorization for that group:

1. Open the User Management page to EXTERNAL AUTHENTICATION.
Navigate to **Settings > User Management**, and display the **EXTERNAL AUTHENTICATION** view.
2. Create a new External Group
Click **NEW EXTERNAL GROUP**.
3. Provide the group name.

Be sure to use the name that you specify in the group attribute of the SAML response. For the above example, use the name turbo_admin_group.

4. Specify the group's authorization

For the above example, since this is turbo_admin_group, you should set the **ADMINISTRATOR** role, and you should not set any scope (grant full access to the environment).

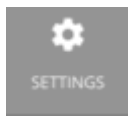
After you configure this group in Turbonomic, then any member of turbo_admin_group that the IdP returns will have full administrator privileges on your Turbonomic installation.

Maintenance: Logging and Troubleshooting

The Maintenance Options Page provides tools to set logging levels and to export data for technical support, and import diagnostic files from Technical Support. Many of these tools are for advanced users. You should contact IBM technical support before you use them.

To execute these actions, navigate to the Maintenance Options page:

1. Navigate to the Settings Page.



Click to navigate to the Settings Page.

2. Choose Maintenance Options.



Maintenance Options

Data Retention

Data Retention

SAVED AUDIT-LOG ENTRIES <input type="text" value="365"/> Days	DAILY SAVED STATISTICS <input type="text" value="60"/> Days	HOURLY SAVED STATISTICS <input type="text" value="72"/> Hours
MONTHLY SAVED STATISTICS <input type="text" value="24"/> Months	SAVED PLANS <input type="text" value="14"/> Days	SAVED REPORTS <input type="text" value="30"/> Days

Turbonomic gathers metrics from your environment to provide historical reports. To optimize data storage, it consolidates the data into three groups - Hourly, Daily, and Monthly. Daily statistics consolidate Hourly data, and Monthly statistics consolidate Daily data. Turbonomic also saves plans, reports, and audit log entries.

You can always modify the default values to meet your requirements. Remember that the longer the retention period, the more storage is required.

HTTP Proxy

HTTP Proxy

APPLY CONFIGURATION

☐ Enable Proxy

If your environment requires an HTTP proxy for Turbonomic to access the web, provide the credentials here.

Diagnostics

Diagnostics ⓘ

EXPORT DIAGNOSTICS TO TURBONOMIC

DOWNLOAD DIAGNOSTICS

If you are experiencing problems with Turbonomic, your support engineer might request that you export diagnostic data. You can export the data and then send it to the support engineer as requested.

Feedback and Diagnostics

Feedback and Diagnostics

Allow Turbonomic to collect anonymized usage data and non-confidential environment statistics to improve your experience. We never collect usernames, passwords, server names, IP addresses, page content, or other information of this kind.

☐ Share anonymized usage data and environment statistics

APPLY SETTING AND REFRESH

Turbonomic relies on feedback from customers to continuously improve the product. One way that we receive feedback is by collecting anonymized and non-confidential data as users go about using the product. Your participation in this initiative is voluntary (and you can opt out at any time), but it does help Turbonomic deliver a better user experience for customers.

You can enable this feature to participate. Note that you must have the **Administrator** role to enable or disable this feature. If enabled, Turbonomic collects browser event data for *all* users logged in to the product, and reviews the data on an ongoing basis to make improvements.

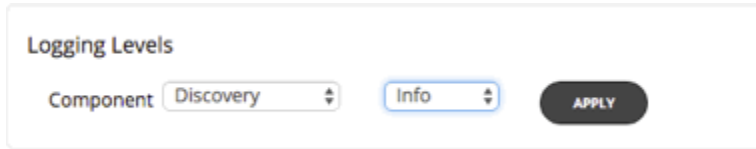
For example, when a product user opens the Plan page in the user interface, Turbonomic records the loading of that page as a browser event and then collects non-confidential data, such as how long it took to load the page and on which browser. Turbonomic will never collect sensitive data, such as the user's IP address or location. If page loading is consistently slow over time and across users, Turbonomic can introduce measures to improve performance.

When you install the product for the first time, you are given the option to enable this feature. For product upgrades, Turbonomic keeps the previous version's setting. You can always change the setting from the Maintenance Options page.

Note:

To learn more about Turbonomic's privacy policy, visit <https://www.turbonomic.com/privacy-policy>.

Logging Levels

A screenshot of a web interface titled "Logging Levels". It features a "Component" label followed by two dropdown menus. The first dropdown is set to "Discovery" and the second is set to "Info". To the right of these dropdowns is a dark grey button labeled "APPLY".

You can set the level of logging for different components of the Turbonomic platform. You should be aware that setting more verbose logging levels increases the disk space required to store the log files. You normally change these settings only while you're working with a Turbonomic support engineer.

The Updates Page

Use the Updates page to get information about your Turbonomic version.

The **ABOUT** button shows the current version and build of your Turbonomic installation. It also lists the platform components by name and version.

Note:

For complete update instructions, see the Installation Guide.

To navigate to the Updates page:

1. Navigate to the Settings Page.

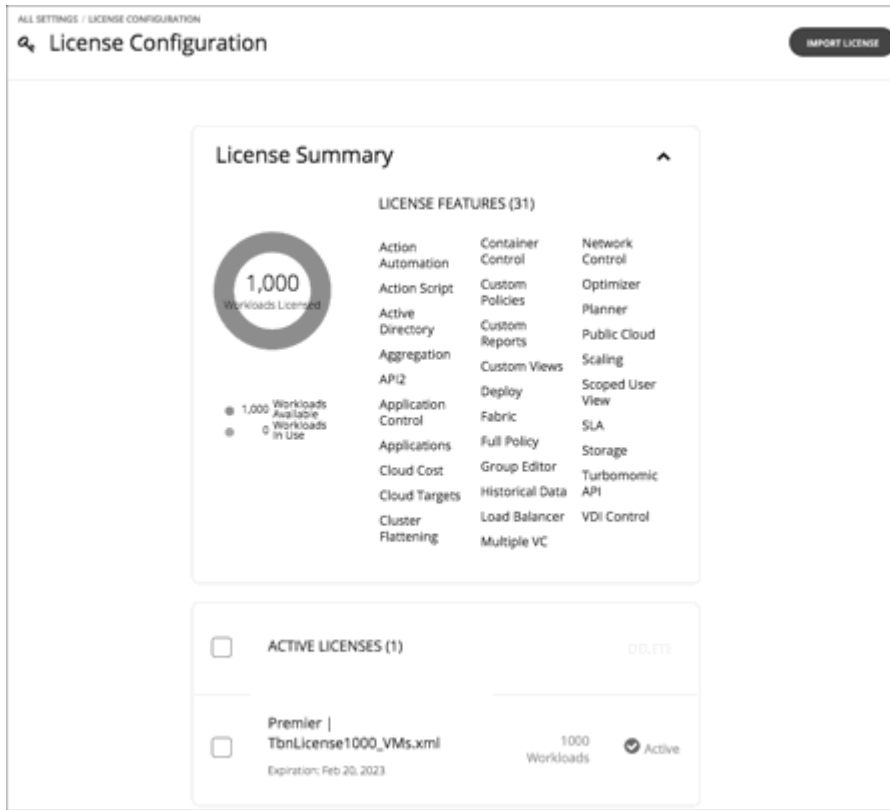


Click to navigate to the Settings Page.

2. Choose Updates.



License Configuration



To activate the full range of Turbonomic features, you must purchase the appropriate license. When you purchase the license, IBM sends the license file to you in an e-mail message.

Note:

Turbonomic bases its licensing on the number of workloads a given license supports. If your environment exceeds that count of workloads, then you are no longer in compliance with your Turbonomic requirements, and some features will be restricted. For example, you will not be able to configure new targets. You should upgrade your license as soon as possible.

To upgrade your license to support a larger environment, contact your Turbonomic representative to get the correct license, and to make sure you know how to install it correctly.

A product license enables specific features as well as a specific number of workloads that you can manage. You can add additional licenses to Turbonomic as a way to increase the number of workloads your installation can manage. Note that as you add more licenses, they must all support the same feature set.

The License Configuration page shows you:

- The number of active workloads you can manage under this license
- How many workloads are currently active
- The set of features this license enables
- A list of current, active licenses

To navigate to the License Configuration page:

1. Navigate to the Settings Page.



2. Choose License.



To activate a license or to update your current license:

1. Obtain your license.

IBM sends the license file to you in an e-mail message. Save the license file on your local machine so you can upload it to your Turbonomic installation.

2. Apply the license to your Turbonomic installation.

First click **IMPORT LICENSE**. Then browse to the license file that you saved and open it. Or you can drag the file into the **Enter License** fly-out.

After you have uploaded the file, click **SAVE**.

After you have activated your license, you can then add more licenses to increase your workload coverage, or you can license a higher feature set.

Note:

As you apply new licenses to Turbonomic, you must be sure that they are for the same edition or feature set. If you try to apply an incompatible license file, Turbonomic displays an *Invalid Feature Set* error. To apply the new license you must either delete your current license so you can install the new feature set, or you must obtain a different license file that matches your current feature set.

After you install a new license, you should clear your browser cache and reload the Turbonomic user interface.

To increase your licensed workload coverage:

1. Obtain your additional license.

Note that your additional licenses must match the feature set of your current license.

2. Apply the license to your Turbonomic installation.

To upgrade your license to a higher feature set:

1. Obtain your new license for the new features.

You should obtain a license that supports at least the same number of workloads as your current license.

2. Delete your current license from Turbonomic.

On the license page, select all the licenses that you currently have installed, then click **DELETE**.

3. Apply the license to your Turbonomic installation.

Email Settings

Configure email settings to enable email communication from Turbonomic.

1. Navigate to the Settings Page.



Click to navigate to the Settings Page. From there, you can perform a variety of Turbonomic configuration tasks.

2. Navigate to the Email Settings Page.

From here, you can configure:

- SMTP Settings
- General Email Settings

SMTP Settings

SMTP Settings ⓘ

SMTP SERVER

0.0.0.0

SMTP PORT

25

USERNAME

PASSWORD

ENCRYPTION

☒ None

☐ Ssl

☐ Tls

The SMTP Settings fields identify the mail relay server you use on your network to enable email communication from Turbonomic.

If the server requires authentication, provide the username and password here. You can also choose the following encryption options for notifications:

- None
- Ssl
- Tls

General Email Settings

General email settings

'FROM' ADDRESS

email@organization.com

Use this setting to specify the return address (the FROM address) for emails that Turbonomic generates and sends.

Chapter 8. API Reference

Welcome to the Turbonomic REST API Guide. This guide will help you to use the Turbonomic REST API as you script interactions with the Turbonomic software and develop integrations between Turbonomic and other software applications.

The REST API exposes Turbonomic data and processing to remote access via HTTP GET, POST, PUSH, and DELETE methods.

The Turbonomic user interface is a client to this API, and every feature exposed in the user interface is the product of API calls. To understand the API, you should have a working knowledge of the Turbonomic user interface, the features it exposes, the data it uses, and the use cases that it supports. In most cases, if you want to script some Turbonomic behavior, you should be able to execute most of that behavior via the user interface. Stepping through these use cases in that context will help you plan and implement your scripts.

To get the most out of the REST API, you should understand how Turbonomic organizes its underlying data, and how the various REST resources map to that organization. This introductory section includes discussions of the data that underlies:

- Markets and how they represent your environment (see [Markets](#))
- Plans and an overview of how to work with them (see [Plans](#))
- Workload placement policies and how they are represented (see [Workload Placement Policies](#))
- Reservations for deployment, and how to set them up (see [Reservations](#))

Note:

This guide is not a comprehensive reference to every possible setting and data payload in the REST API. Many endpoint descriptions include samples of API data objects, but they cannot document every possible combination of inputs. For a complete reference to the API, use this guide in conjunction with the Turbonomic REST Swagger-UI documentation. For more information, see [Turbonomic REST API Swagger Documentation](#).

API Guide Revision History

Each new revision of the API Guide includes the following changes. We post a new revision of the API Guide for each major release, if the API undergoes significant change between major releases, or to correct significant errors in the API Guide.

API Guide Version	Changes
8.6	<p>New revision for the major release, 8.6.0.</p> <p>For a list of fixes and improvements that were incorporated in the API for this release, see Turbonomic 8.6.0 API Fixes and Improvements.</p> <p>For a list of upcoming deprecations, see Appendix: API Deprecation Contract.</p>
8.5.1	<p>Deprecated features were originally with this release. For a list of deprecated features that have been finalized (fully implemented or removed from the API), see Appendix: API Deprecation History.</p> <p>For a list of upcoming deprecations, see Appendix: API Deprecation Contract.</p>
8.5	<p>New revision for the major release, 8.5.0.</p>

API Guide Version	Changes
	<p>For a list of fixes and improvements that were incorporated in the API for this release, see Turbonomic 8.5.0 API Fixes and Improvements.</p> <p>For a list of upcoming deprecations, see Appendix: API Deprecation Contract.</p>
8.4.3	<p>Deprecated features that were originally scheduled to be finalized for version 8.4.1 are finalized with this release. For a list of deprecated features that have been finalized (fully implemented or removed from the API), see Appendix: API Deprecation History.</p> <p>For a list of upcoming deprecations, see Appendix: API Deprecation Contract.</p>
8.4	<p>New revision for the major release, 8.4.0.</p> <p>For a list of fixes and improvements that were incorporated in the API for this release, see Turbonomic 8.4.0 API Fixes and Improvements.</p> <p>For a list of upcoming deprecations, see Appendix: API Deprecation Contract.</p>
8.3	<p>New revision for the major release, 8.3.0.</p> <p>For a list of fixes and improvements that were incorporated in the API for this release, see Turbonomic 8.3.0 API Fixes and Improvements.</p> <p>For a list of upcoming deprecations, see Appendix: API Deprecation Contract.</p>
8.2.0b	<ul style="list-style-type: none"> Improved reference materials for the following endpoints: <ul style="list-style-type: none"> Search Scenarios Settings Updated the reference URL for accessing the Swagger UI to: <a href="https://<Your_Turbonomic_IP>/swagger/external/index.html">https://<Your_Turbonomic_IP>/swagger/external/index.html

Getting Started with the Turbonomic REST API

The easiest way to see results with the API is to try calls in the Swagger UI. To use the Swagger UI, navigate to:

https://<Your_Turbonomic_IP>/swagger/external/index.html

You can use the Swagger UI to navigate to different endpoints and try out their methods. For example, if you navigate to the Users endpoint you can get a listing of all the users that are specified for your Turbonomic installation. For more information, see [Turbonomic REST API Swagger Documentation](#).

Ultimately, you will want to implement scripts that use the API to get data, execute actions, or integrate Turbonomic with other processes. As you work with the API, you need to know about:

- Authentication
- URI Structure
- Response Format
- Time in the Turbonomic API

Authentication

To use the API, you must have a valid user account on the Turbonomic instance. Also note that accounts can have different roles. The API will only execute commands that are valid for your user

role. For example, to execute Turbonomic recommended actions, your account must have a role of either administrator, deployer, or automator.

To make API calls, you create an authentication token and pass it with each subsequent request to the Turbonomic API. A common way to do this is to store the cookie locally.

Example: `curl -s -k -c /tmp/cookies -H 'accept: application/json' 'https://localhost/api/v3/login?hateoas=true' -d 'username=administrator&password=password'`

Then, each request must use the `-b cookie-filename` parameter to use the session cookie delivered by the login request.

Note: For a more complete explanation, see the [Authentication Recipe](#) in the API Cookbook.

URI Structure

To use the Turbonomic REST API, your client will make HTTP requests to specific REST resources. The Turbonomic REST API supports the standard HTTP methods:

- GET
Get lists of entities or data objects, get individual items.
- POST
Create new objects in the Turbonomic environment, or specify filters for certain queries.
- PUT
Incrementally modify existing entities or objects.
- DELETE
Delete entities or objects.

The base URI structure for a Turbonomic REST API resource is:

```
https://<Your_Turbonomic_IP>/api/<API_version>/<resource_name>
```

For example, to list the users in your installation:

```
https://111.222.33.44/api/v3/users
```

Response Format

The Turbonomic REST API returns data as JSON objects. Turbonomic refers to these objects as Data Transfer Objects or DTOs. A DTO is an array of key-value pairs that describe the data you have requested, or the data that is the result of executing a POST or PUT. For example, if you GET the users defined for an installation of Turbonomic, the API returns a DTO similar to this:

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/users/_4T_7kwY-Ed-WUKbEYSVIDw"
      }
    ],
    "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
    "displayName": "Administrator User",
    "username": "administrator",
    "roleUuid": "_4UAioQY-Ed-WUKbEYSVIDw",
    "roleName": "administrator",
    "loginProvider": "Local",
    "type": "DedicatedCustomer",
    "showSharedUserSC": false
  }
]
```

```
]
```

In this case, the DTO is an array of one object. In other words, there is only one user account defined for this installation of Turbonomic. The user object begins with a `links` array that gives the URL to this user account. It then follows with properties to describe the given user account.

Note that in most cases to execute a PUT or POST, you will pass the parameters to create the object via a DTO. These DTOs are similar to the associated response DTOs, but they are not identical. For this example of a user account, the response DTO does not include the user account password, but the DTO to create an account must include the password.

You can try out different REST methods in the Swagger UI to see typical response DTOs.

Time in the Turbonomic API

The Turbonomic REST API contains requests that require a start time and/or an end time to create or filter information. Time may be entered in three different formats:

- ISO 8601 Date and Time Format

YYYY-MM-DDTHH:MM:SS. For example, 2018-10-07T12:38:17

- Epoch Time

Epoch Time is represented as the number of seconds that have elapsed since midnight UTC, January 1, 1970. For example, 1514764800 corresponds to January 1, 2018 12:00:00 AM UTC.

- Relative time

Relative time is represented as the time relative to when the call is executed. For example, a start time of `-1w` and an end time of `-1d` indicates that the results should include entries from a week before the call is executed, to the day before the call is executed. Relative units are case-sensitive. Turbonomic supports the following relative units:

- m — minutes
- h — hours
- d — days
- w — weeks
- M — months
- y — years

Pagination in the Turbonomic API

Some API calls return very large datasets. Turbonomic recommends using the pagination features at all times. This is particularly important for larger environments managed by Turbonomic. Via scopes and filters for individual requests, data may be preliminarily filtered. Using the `limit` and `x-next-cursor` parameters, the data can be returned in manageable chunks.

For example:

```
https://10.10.10.10/api/v3/markets/214075923753936/entities/stats?
limit=5&ascending=true
```

The request above is to obtain statistics for all entities in a specific market. `limit=5` indicates that each page of returned data should have 5 results.

The headers in the returned data will now include `x-next-cursor: 5`. In order to retrieve the next page of results, use the cursor in the next request:

```
https://10.10.10.10/api/v3/markets/214075923753936/entities/stats?
cursor=5&limit=5&ascending=true
```

When the final page is reached, the `x-next-cursor` will be empty.

If a request features the `orderBy`, `limit`, or `cursor` parameters, using one of those parameters will return paginated results.

Turbonomic REST API Swagger Documentation

You can try out different REST methods in the Swagger documentation to see typical response DTOs.

To access the Turbonomic Swagger documentation, navigate to:

`https://<Your_Turbonomic_IP>/swagger/external/index.html`

This documentation uses a standard Swagger-UI application that delivers documentation for all the methods on the different endpoints in the API. This documentation includes a description of the call, a list of parameters to pass, and descriptions of the JSON payloads you POST or PUSH, as well as the payloads you get in the response. If you view the MODEL of a JSON payload, you can navigate the JSON structure to see descriptions of the different object fields.

To access the API, the Swagger-UI requires authentication. If you have already logged into Turbonomic, your browser session should have a current authentication cookie. The Swagger-UI uses this same cookie for its API authentication.

For each method, the Swagger doc includes a **Try it out** feature where you can set up a call through the Swagger-UI, and then execute it. This generates the following information as a response:

- A curl request for your call

The curl commands generated by Swagger may need some modification for use in your environment (for example, escaping quotes or adding the `-k` modifier in order to use HTTP URLs).

- A standard HTTP request for your call
- The server response code
- The response body – The JSON data that the API call returns
- Response headers

Note: If you use the SwaggerUI to try out API calls, and the API call returns an error (for example, your call uses incorrect syntax), under some circumstances SwaggerUI does not display the error, and the field for the returned data is empty.

Turbonomic Markets

Turbonomic uses market-based analysis to perform workload management. To do this, it constructs a model of your environment, representing each entity as a buyer and seller in a market. You can access this model via a named market resource.

At any time, your Turbonomic appliance can have a number of markets in memory. To get a list of the current markets in your appliance, execute the following URL:

GET: `/rest/markets`

This listing returns the main real-time market, plus any plan markets that are in memory at the time of the call. Note that you can pass group UUIDs to set a scope for the call. In that case, the call returns only markets for plans that include the passed groups in their scope.

The Real-Time Market

The real-time market performs analysis and workload management on your environment. You can use the real-time market to access entities and get current or historical data about them.

The real-time market displayName is Market. This market should always be in the RUNNING state. Under no circumstances should you use the API to stop this market.

Turbonomic performs discovery to populate the topology it manages (the collection of entities in the real-time market). For this reason, you should be careful not to delete entities from or add entities to the real-time market.

For the real-time market, you can safely execute POST, PUT, and DELETE calls to:

- Post a query filter to get filtered lists of actions, notifications, and stats for the real-time market
- Post to create placement policies in the real-time market
- Delete to remove placement policies from the real-time market
- Put to edit placement policies on the real-time market
- Post a scenario to the real-time market to run a plan

When you run a plan scenario against the real-time market, Turbonomic creates a copy of the real-time market, and modifies the copy according to the plan scenario.

Note:

It is possible to execute POST or DELETE methods to modify the topology of the real-time market. However, it is highly unlikely that you would have a reason to do so. You should be aware that changes to the real-time market will affect the analysis Turbonomic performs. For example, if you remove a VM from the real-time market, Turbonomic can no longer manage its placement. The VM will still be present in your environment, but it will no longer be managed by Turbonomic. However, you can't reliably use this technique to make specific entities unavailable to Turbonomic. For the next discovery pass, Turbonomic will rediscover the deleted entity, and it will appear in the real-time market again.

Plan Markets

Turbonomic can have markets other than the real-time market in memory. These other markets represent plans.

A plan market begins as a snapshot of the real-time market. You POST a scenario to the real-time market, and Turbonomic does two things:

- It makes a copy of the real-time market, to create a plan market. This plan market is just like the real-time market, except for any changes that were declared in the scenario. For example, if the scenario declares a scope for the plan, then the plan market only contains entities that are within that scope.
- It runs economic cycles (buy/sell cycles) against this plan market until there are no more meaningful improvements to be made. At this point the plan run is completed.

Note that once Turbonomic creates the plan market, that market stays in memory until you delete it. Also note that you can later apply a scenario to the plan market. This is how you run a plan on a plan. The logic flow is the same, and Turbonomic creates yet another plan market to run the analysis.

Internal-Use Plans

Turbonomic regularly runs plans to generate data that it displays in the GUI — The Cluster Capacity and Project Cluster Resources dashboards both display data generated by regularly-run plans.

A plan market that is for internal use includes the substring `_BasePlan` in the `displayName`. You should not modify these plan markets for any reason.

User-Created Plans

Users can create plans to run what-if scenarios in the environment, and the results are saved as a plan market. At any time, each user account can have multiple plan markets loaded in the Turbonomic instance.

You identify planner markets by their names. A plan name is specified as `<PlanType><userName>_<arbitraryID>`.

For example, a valid plan name is `CLOUD_MIGRATION_cud_1493140514716`. To find out which user owns this plan, you can parse out the user's name and query the API for that user's account information.

When you get a plan market, the response includes information such as:

- `uuid`: The market's identifier.
- `state`: Whether the plan succeeded or not. The state can be one of:
 - `CREATED`
 - `READY_TO_START`
 - `RUNNING`
 - `COPYING`
 - `SUCCEEDED`
 - `STOPPING`
 - `STOPPED`
 - `USER_STOPPED`
 - `DELETING`

As long as a plan market is running, Turbonomic is still calculating the plan results. If the market is stopped, then the plan has been run and you can access data from this market to see the plan results. You can make a PUT call to the market to stop a plan that is running.

For a plan market, you can execute the same POST, PUT, and DELETE methods that you would execute on the real-time market. These include:

- POST a query filter to get filtered lists of actions, notifications, and stats for the plan market
- POST to create placement policies in the plan market
- DELETE to remove placement policies from the plan market
- PUT to edit placement policies on the plan market
- POST a scenario to the plan market to run a plan on plan

You can also safely execute the following methods on a plan market:

- DELETE a plan market
- PUT to save or stop a plan market

Note:

It's possible to stop a plan market through the GUI or the API. Also, a plan may have been stopped before it finished its calculations. In this case, the plan results will be incomplete.

Running Plans

A plan is a simulation or what-if scenario that explores the results of possible changes to your environment. To run a plan, Turbonomic creates a snapshot copy of your real-time market and applies changes to it. It then uses the Economic Scheduling Engine to perform analysis on that plan market.

Before working with plans in the API, you should be familiar with plans via the GUI. You should know what plans can accomplish, and how to specify the plan settings such as:

- Plan scope
- Changes to workload in the environment (adding or removing VMs)
- Changes to supply (adding, removing, or reconfiguring hardware)
- Changes to placement (migrating to the cloud or a different cluster)
- Changes to constraints

To create a plan, you first specify a plan scenario. This is an object that contains all the plan settings. The scenario object contains an array of changes, and each change declares a setting that you want to make.

After you create a scenario, you POST it to a market. In most cases you will post it to the real-time market. When you post the scenario to the market, Turbonomic does two things:

- It makes a copy of the market, to create a plan market. This plan market is just like the original market, except for any changes that were declared in the scenario. For example, if the scenario declares a scope for the plan, then the plan market only contains entities that are within that scope.
- It runs economic cycles (buy/sell cycles) against this plan market until there are no more meaningful improvements to be made. At this point the plan run is completed.

Saving and Deleting Plan Markets

As you run a plan, Turbonomic performs analysis and shows the results. It also serializes and saves the plan results so users can load the results into the GUI at a later time.

Note:

Updates to Turbonomic can change the data format for the saved plan results. In that event, then the results will be inconsistent. After each update to Turbonomic, you should regenerate all the plans you want to save, and save them again.

To delete a plan via the API, just execute a DELETE method on the plan market.

Creating Scenarios

The first step for a plan is to create the scenario. Note that a scenario is entirely separate from the plan. You create a scenario and then POST it to a market to create the plan. But the scenario still exists in memory, and you can apply it to a different market if you wish. For example, you can apply the same scenario to the real-time market at different times.

To create a scenario, use the POST: `/rest/scenarios/{name}` method. This method takes three parameters:

- `scope`

An array of group UUIDs. For a scope of multiple groups, you must specify groups of the same type.

- `projection_days`

For a projection scenario, the days to mark each projection period

- `input`

A ScenarioApiInputDTO that can specify all the settings for a scenario.

The `input` parameter, a ScenarioApiInputDTO, is an object that you can POST to the API to specify scenario settings. The API includes methods to create and delete scenarios. In most cases, you will create a scenario by POSTing or PUTing a ScenarioApiInputDTO with changes to declare the scenario settings you want. Note that the API includes methods you can use to PUT many of these settings into a specific scenario by passing properties directly in the URL. However, you can also make these settings with the ScenarioApiInputDTO. Learning to use this DTO is the most consistent way to create and modify a scenario.

Note that as you create a scenario you can POST all of its settings in the ScenarioApiInputDTO, or you can create an incomplete scenario, and then PUT other changes into the scenario at a different time.

Creating a Projection Scenario

Projection plans calculate infrastructure requirements into the future, so your environment can accommodate changes to workload requirements over time. In a single plan you can specify the scope of the plan, how far into the future to project, and by what increments of time. For example, you can project the requirements of a specific datacenter one year into the future, showing how requirements change at one-month intervals.

When you create a projection scenario via the API, you provide the projection periods as an array of the days from today that you want to project. For example, 0 for today, 30 for 30 days from today, 60 for 60 days from today, and so on.

To create a scenario for a projection plan:

- Scope the scenario

A projection plan requires a scope to the scenario.

- Create a change in the plan of type PROJECTION_PERIODS

This change identifies the plan periods that you want, as an array of days.

```
{
  "changes": [
    {
      "type": "PROJECTION_PERIODS",
      "projectionDays": [0, 30, 60, 90]
    }
  ]
}
```

- For any plan changes that you want to repeat on specific projection periods, specify a `projectionDays` array for that change. Note that the items in this array must match the `projectionDays` that you specified for the `PROJECTION_PERIODS` change.

For example, assume you specified `"projectionDays": [0, 30, 60, 90]` for the initial projection:

- Valid: `"projectionDays": [0, 30, 60, 90]`
- Valid: `"projectionDays": [30, 90]`
- Not valid: `"projectionDays": [0, 35, 70, 90]`

This listing shows a plan scenario that scopes the plan market, sets up a projection for four periods, and adds one VM to the inventory for two out of four projection periods:

```
{
  "displayName": "My Projection",
  "changes": [
    {
      "type": "SCOPE",
      "scope": [
        {
          "uuid": "5678a46e9716657be88b5e1217df91436e13e4ff",
          "className": "Group",
          "entitiesCount": 2,
          "groupType": "VirtualMachine",
        }
      ]
    },
    {
      "type": "PROJECTION_PERIODS",
      "projectionDays": [
        0,
        30,
        60,
        90
      ]
    },
    {
      "type": "ADDED",
      "targets": [
        {
          "uuid": "564d89f4-190b-de1b-cb28-3e2f2126ab48"
        }
      ],
      "value": "1",
      "projectionDays": [
        30
      ]
    }
  ]
}
```

Placement Policies in Plans

You can enable or disable placement policies in a plan. This is useful to see how the environment would change if you had a different set of constraints. It's important to note that a placement policy exists in the

context of a market. To get a placement policy, query the market that contains it. To create a placement policy for a plan, you will create the policy and add it to the plan market.

If you want to enable or disable a placement policy in a plan, you specify that as a change in the scenario. Because the placement policy exists in a market, you have to know which market you will run the plan against, and get the policy from that market.

For example, if you will run the plan against the real-time market, you would:

- Query the real-time market for the policy you want
- Give that policy's UUID in the scenario change object
- In the scenario change object — Specify to enable or disable the policy
- When the scenario is complete, POST the scenario to the real-time market

Remember that when you run a plan, Turbonomic creates a new plan market. This plan market will contain a copy of the placement policy, and will enable or disable it, depending on your setting.

Workload Placement Policies

Workload Placement Policies affect how Turbonomic calculates placement for the workloads in your environment. Policies can enforce specific business rules to constrain placement, and they can remove boundaries to enable placement calculations across cluster or datacenter boundaries.

A placement policy exists in the context of a market — Either the real-time market or a plan market. Each market has its own set of placement policies. Even if a plan market is an exact copy of the real-time market, the plan market has its own placement policies, each with its own UUID.

Before you work with placement policies via the API, you should understand how they work in the user interface. You should understand the types of placement policies you can create, and the effect of each on market analysis.

The API supports the following types of policies:

- **AT_MOST_N**: Only the given number of consumers can run on a single member of the providers group. This is set in the `capacity` property of the policy object.
- **BIND_TO_GROUP**: The consumers can only run on members of the provider group.
- **BIND_TO_COMPLEMENTARY_GROUP**: The consumers cannot run on any members of the provider group.
- **MUST_RUN_TOGETHER**: These consumers must run on the same provider entity.
- **AT_MOST_N_BOUND**: Only the given number of consumers can run on a single member of the providers group, AND The consumers can only run on members of the provider group.
- **MERGE**: Remove cluster boundaries for the specified clusters.
- **BIND_TO_GROUP_AND_LICENSE**: Create a license group.

When you get a policy, the returned object describes the policy type, as well as the consumer and provider groups. When you create a policy, you do not have to provide the full data. You provide:

- `buyerUuid`: The group of consumers for this policy.
- `sellerUuid`: The provider group for this policy.
- `type`: The policy type.
- `policyName`: A display name for this policy.
- `enabled`: Whether to enable the policy in the market. Can be `true` or `false`.
- `capacity`: For an **AT_MOST_N** or **AT_MOST_N_BOUND** policy, the number of consumers to allow on a provider entity.
- `mergeType`: For a **MERGE** policy, the type of clusters to merge. Can be one of `Cluster`, `StorageCluster`, `DesktopPools`, or `DataCenter`.
- `mergeUuids`: The groups that you want to merge. The group type must match the `mergeType`.

For example, to create a DON'T PLACE policy, post the following inputDto to the market:

```
{
  "buyerUuid": "f82dbbc2b3366052f3bc1ac8a68c9c06b0eb182a",
  "enabled": false,
  "policyName": "PolicyFromApi",
  "sellerUuid": "4a2f5f132ae690af147ccfd6ea9839e79da3db79",
  "type": "BIND_TO_COMPLEMENTARY_GROUP"
}
```

To edit a placement policy, PUT an input Dto to the given policy. Specify the changes you want in the input Dto.

Calculating Reservations and Workload Placement

Turbonomic includes the capability to reserve resources for VMs you plan to deploy in the future. Turbonomic calculates optimal placement for these VMs and then reserves the host and storage resources that they need.

To reserve VMs, you will choose a VM template, specify any placement constraints, set how many instances to reserve, and then indicate whether to reserve now or in the future. Because reserved VMs do not yet exist, they do not participate in the real-time market. VM templates specify the resource requirements for each reserved VM, including:

- Compute and storage resources allocated to each VM
- Consumed factor. This is the percentage of allocated CPU, memory, or storage that the reserved VM will utilize.

Note that before using the API to work with reservations, you should understand how reservations work from the user interface.

With the API, you can perform the following:

- Get list of reservations
- See the current placement for the reservation workloads
- Create reservations
- Delete a current reservation

Getting Reservation Information

To get a list of current reservations, execute `/rest/reservations`. This returns a list of all active reservations. If you know the UUID of the reservation you want, you can pass it to get data for just that reservation.

Each reservation object includes:

- Display name
- Status — can be:
 - DEPLOYING — Turbonomic is deploying the workload
 - DEPLOY_SUCCEEDED — The workload was successfully deployed
 - IN_PROGRESS — Placement calculation is in progress
 - PLACEMENT_SUCCEEDED — For a new reservation, the environment has sufficient resources to place the workload; if you specified a reserve date, this will be an active reservation
 - PLACEMENT_FAILED — For a newly created reservation, the environment doesn't have resources to place the workload; if you specified a reserve date, this will be an unfulfilled reservation
 - RETRYING — Turbonomic is trying to place the workload of an unfulfilled reservation
- Time the reservation was created, time to deploy, and time it will expire
- A description of the reserved workload

- The deployment profile that identifies the physical files that will be copied to deploy the workload, as well as optional placement limitations.
- Statistics for the compute and storage resources the reservation sets aside

For example, this listing shows a reservation for one VM:

```
{
  "uuid": "_kWZHIDDmEeePgeXuo0RRbw",
  "displayName": "MyReservation",
  "count": 1,
  "status": "PLACEMENT_SUCCEEDED",
  "reserveDateTime": "Thu May 04 16:27:29 UTC 2017",
  "expireDateTime": "Thu Aug 31 16:27:29 UTC 2017",
  "deployDateTime": "Thu Aug 31 16:27:29 UTC 2017",
  "reserveCount": 1,
  "demandEntities": [
    {
      "uuid": "_kWgb7TDmEeePgeXuo0RRbw",
      "displayName": "MyReservation_C0",
      "className": "VirtualMachine",
      "template": {
        "uuid": "T423f548d-cadc-e525-6df4-1f90724cf696",
        "displayName": "vsphere-dc3.dev.mycorp.com::TMP-SUSE64",
        "className": "VirtualMachineProfile"
      },
      "deploymentProfile": {
        "uuid": "_gHJ0ICXxEeePgeXuo0RRbw",
        "displayName": "DEP-SUSE64",
        "className": "ServiceCatalogItem"
      },
      "placements": {
        "computeResources": [
          {
            "stats": [
              {
                "name": "numOfCpu",
                "value": 1
              },
              {
                "name": "cpuSpeed",
                "value": 2603
              },
              {
                "name": "cpuConsumedFactor",
                "value": 0.5
              },
              {
                "name": "memorySize",
                "value": 2097152
              },
              {
                "name": "memoryConsumedFactor",
                "value": 0.75
              },
              {
                "name": "ioThroughput",
                "value": 0
              },
              {
                "name": "networkThroughput",
                "value": 0
              }
            ]
          },
          {
            "provider": {
              "uuid": "Virtual_ESX_42381da5-12fa-1e82-2f1c-887419380d43",
              "displayName": "hp-esx21.corp.vmturbo.com",
              "className": "PhysicalMachine"
            }
          }
        ],
        "storageResources": [
          {
            "stats": [
              {
                "name": "diskSize",
                "value": 18432.363
              },
              {
                "name": "diskIops",
```

```

        "value": 0
      }
    ],
    "provider": {
      "uuid": "10545c15-7687ef26",
      "displayName": "QS2:ESXDC3DS1",
      "className": "Storage"
    }
  }
}
]
}
]
}
}

```

Creating a Reservation

To create a reservation, you POST an input DTO that defines the reservation's:

- **action:** The action type: RESERVATION
- **demandName:** The display name of the reservation — If you do not specify names for the added workloads, this will be the root name for new VMs
- **placementParameters:**
 - **constraintIDs:** An array of UUIDs for placement policies that will affect the calculated placement
 - **count:** The number of workloads to place
 - **entityNames:** An array of names for the placed VMs — The array length should equal count
 - **geographicRedundancy:** If **true** place the workloads on unique hosts, otherwise Turbonomic can place multiple workloads on the same host
 - **templateID:** The UUID of the template that you will use to place this workload — Note that the template must include a reference to the deployment profile that you specify in **deploymentParameters**
- **expireDateTime:** When to cancel a reservation if Turbonomic cannot place all the workloads by that date — for a RESERVATION action, Turbonomic automatically sets the deploy time to equal this time
- **reserveDateTime:** The time to calculate the workload placement and create the reservation — This time cannot be earlier than the time that you POST the reservation to the API

The following listing shows an input DTO that creates a reservation. It will place four workloads, and it gives specific names to each one.

```

{
  "action": "RESERVATION",
  "demandName": "MyReservation",
  "expireDateTime": "2017-10-10T12:38:17+00:00",
  "parameters": [
    {
      "deploymentParameters": {
        "deploymentProfileID": "_c9CJMDDAEeePgeXuo0RRbw"
      },
      "placementParameters": {
        "geographicRedundancy": false,
        "count": 4,
        "entityNames": [
          "foo", "bar", "baz", "bonk"
        ],
        "templateID": "_UKsnkJkSEeCHc0XEhZJExA"
      }
    }
  ],
  "reserveDateTime": "2017-05-04T18:22:12+00:00"
}

```

Async Placement Calculation

When you POST a reservation, Turbonomic runs a plan to calculate the optimal placement of the workloads. Depending on the size of the reservation, this can take a significant amount of time. The

API calculates the placement asynchronously. If your script relies on the reservation, you should verify that the reservation has completed before moving on.

When you execute a reservation, the response to your POST shows that the calculation is in progress:

```
{
  "uuid": "_0dPrYTD1EeePgeXuo0RRbw",
  "displayName": "MyReservation",
  "count": 4,
  "status": "IN_PROGRESS",
  "reserveDateTime": "Thu May 04 18:22:12 UTC 2017",
  "expireDateTime": "Tue Oct 10 12:38:17 UTC 2017"
}
```

To examine the placement results, GET the reservation using the UUID that the API gives in the response.

Using Templates

To create a reservation you specify a template that contains workload requirements. VM Templates specify the resources that will be available to the VM, including:

- VCPUs
- Virtual Memory
- Storage
- Network Throughput
- IOPS
- IO Throughput

Note that templates can be created by users, and Turbonomic also discovers templates that are created by the management services in your environment. For example, a hypervisor or a cloud service provider typically manages a number of its own templates — Turbonomic discovers these. You should never edit a discovered template.

To see whether a template is discovered, GET the template you're interested in and look for the `discovered` property. This will be `true` or `false`.

Turbonomic REST API Endpoints

The REST API resources give you full access to the Turbonomic software. This is a complete API that exposes the full set of Turbonomic capabilities. In fact, the product user interface is implemented as a Turbonomic client that uses this API.

While the REST API resources are documented in the SwaggerUI, this section provides extra details for the more expressive resources in the API.

To access the Turbonomic REST SwaggerUI, open a web browser to:

https://<Your_Turbonomic_IP>/swagger/external/index.html

Utility Requests

In the Turbonomic API Guide, utility requests are the requests within an endpoint that do not return information about your environment, but provide benefits to other calls you may make. For example, <https://10.10.10.10/api/v3/settings/> is a utility request that returns a list of all possible settings managers. This information can be used to find settings on your instance, but the `/settings/` request itself does not provide any instance-specific information.

Actions Endpoint

Instead of responding to thresholds, Turbonomic analyzes the operating conditions and constantly recommends actions to keep the entire environment within the desired state. If you execute these actions

(or let Turbonomic execute them for you), the environment will maintain operating conditions that assure performance while also ensuring the lowest possible cost thanks to efficient utilization of your resources.

Using the actions endpoint, you can:

- Get a complete or filtered list of actions in your environment
- Accept or reject actions
- Get statistics related to a specified action
- Get notifications related to a specified action

Actions Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble inputDTOs, or see the potential values of a particular DTO.

Getting the Valid `actionMode` parameters for a Specified Entity and Action

The actions endpoint contains a utility request that shows the possible values for the `actionMode` parameter for a specified entity and action type. These can be used to set or understand the possibilities for various action settings.

To specify an entity/action type, this request takes the following parameters:

action_type

- **START:**
Start an entity, and add it to the Turbonomic market.
- **MOVE:**
Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.
- **SUSPEND:**
Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.
- **ADD PROVIDER:**
This is equivalent to the START action, but for storage entities.
- **CHANGE:**
Move a virtual machine's storage between datastores.
- **PROVISION:**
Add capacity to your environment.
- **RECONFIGURE:**
Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.
- **DELETE:**
This is equivalent to the SUSPEND action, but for storage entities.
- **RESERVE_ON_PM:**
When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.
- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR_EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR_PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

entity_type

- BUSINESS_UNIT
- CLOUD_SERVICE
- CONTAINER
- DATABASE
- DATABASE_SERVER
- DATACENTER
- DISK_ARRAY
- PHYSICAL_MACHINE
- STORAGE
- VIRTUAL_MACHINE
- SWITCH
- VIRTUAL_DATACENTER
- CHASSIS
- STORAGE_CONTROLLER
- IO_MODULE
- APPLICATION_SERVER
- VIRTUAL_APPLICATION
- NETWORK
- APPLICATION
- CONTAINER
- CONTAINER_POD
- LOGICAL_POOL
- DPOD
- VPOD
- LOAD_BALANCER

Example: GET https://10.10.10.10/api/v3/actions/availablemodes?entity_type=PhysicalMachine

Response: An array of strings, where each string is a valid actionMode for the combination provided. In this example, a PROVISION action and the PhysicalMachine entity. An empty response body indicates that the requested entity does not have an action of that type, usually for practical reasons. For example, the Network entity cannot have a MOVE action.

```
[
  "RECOMMEND",
  "DISABLED",
  "MANUAL",
  "AUTOMATIC"
]
```


Getting a List of Entry Points for Actions

The actions endpoint contains a utility request that shows the entry points for other action-related requests. These can be used to find the UUID and details relating to a specific action.

Example: GET <https://10.10.10.10/api/v3/actions>

Response: An array of `LinkApiDTO` objects, where each object contains a URL to get all actions for a specified market, entity, or group.

```
{
  "links": [
    {
      "rel": "Market actions",
      "href": "https://10.10.10.10/api/v3/markets/{uuid}/actions?ascending=true"
    },
    {
      "rel": "Entity actions",
      "href": "https://10.10.10.10/api/v3/entities/{uuid}/actions?ascending=false"
    },
    {
      "rel": "Group actions",
      "href": "https://10.10.10.10/api/v3/groups/{uuid}/actions?ascending=true"
    }
  ]
}
```

Actions Requests

Action requests handle acceptance, rejection, filtering, and exploration of actions on your Turbonomic appliance.

If one or more of the entities in the scope of your request no longer exists in the topology, the `ActionApiDTO` for such entities will contain minimal information about the entities.

Getting a Specified Action

Gets the action details, including the creation time and target entity information, for a specified action UUID.

Example: GET https://10.10.10.10/api/v3/actions/_6QsKkaNWEeiYWYj--U8W5g/details

Response: The full `ActionApiDTO` for the requested action:

```
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/actions/_6QsKkaNWEeiYWYj--U8W5g"
    },
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/actions/2218532354592"
    }
  ],
  "uuid": "_6QsKkaNWEeiYWYj--U8W5g",
  "createTime": "2018-08-19T07:40:57-04:00",
  "actionType": "MOVE",
  "actionState": "PENDING_ACCEPT",
  "actionMode": "MANUAL",
  "details": "Move VirtualMachine Jboss-EAP-10.203 from dc17-host-01.mycorp.com to dc17-host-02.mycorp.com",
  "importance": 7.4150376,
  "target": {
    "uuid": "421d8db4-3fc6-440b-0575-11383c020c6c",
    "displayName": "Jboss-EAP-10.203",
    "className": "VirtualMachine",
    "aspects": {
      "virtualMachineAspect": {
        "os": "CentOS 4/5/6/7 (64-bit)",
        "connectedNetworks": [

```

```

        {
          "uuid": "34f9f5364cd843aa1fe99900621ee3b51a7dc6e5",
          "displayName": "VM Network"
        }
      ],
      "numVCPUs": 2,
      "ebsOptimized": false
    }
  },
  "environmentType": "ONPREM"
},
"currentEntity": {
  "uuid": "34313836-3333-5553-4537-33364e385146",
  "displayName": "dc17-host-01.mycorp.com",
  "className": "PhysicalMachine",
  "environmentType": "ONPREM"
},
"newEntity": {
  "uuid": "34313836-3333-5553-4537-33394e43424e",
  "displayName": "dc17-host-02.mycorp.com",
  "className": "PhysicalMachine",
  "environmentType": "ONPREM"
},
"risk": {
  "uuid": "_CizZoKN2EeiWYj--U8W5g",
  "subCategory": "Efficiency Improvement",
  "description": "dc17-host-01.mycorp.com can be suspended for efficiency",
  "severity": "MINOR",
  "importance": 0
},
"actionID": 2218532354592
}

```

Getting a Filtered List of Actions

Gets a list of actions, given a scope UUID and filtered by an ActionApiInputDTO using one or more of the following criteria:

actionModeList

- **DISABLED:**
Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.
- **RECOMMENDED:**
Recommend the action so a user can execute it via the given hypervisor or by other external means
- **MANUAL:**
Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.
- **AUTOMATED:**
You have directed Turbonomic to execute the action automatically.
- **COLLECTION (UNUSED):**
Legacy action mode, no longer used.

actionStateList

- **DISABLED:**
An action whose policy has been disabled.
- **RECOMMEND:**
An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.
- **PENDING_ACCEPT:**

When the action mode is set to manual, a recommended action that has not been accepted or cleared.

- **ACCEPTED:**

An action that has been accepted, but is not yet in progress.

- **IN_PROGRESS:**

An action that is being executed.

- **SUCCEEDED:**

An action that was accepted and completed successfully.

- **FAILED:**

An action that was accepted and did not complete successfully.

- **REJECTED:**

When the action mode is set to manual, an action that has been rejected by the user.

- **CLEARED:**

When the action mode is set to manual, an action that is no longer recommended by the market.

- **ACCOUNTING:**

For cloud entities, an action to resize in order to use a different instance template.

- **QUEUED:**

When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

actionTypeList

- **START:**

Start an entity, and add it to the Turbonomic market.

- **MOVE:**

Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.

- **SUSPEND:**

Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.

- **ADD_PROVIDER:**

This is equivalent to the START action, but for storage entities.

- **CHANGE:**

Move a virtual machine's storage between datastores.

- **PROVISION:**

Add capacity to your environment.

- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR_EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR_PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

cleared

Default: false.

When true, actions that were removed from the action list before being executed will be returned.

costType

- **Saving**

An action that will decrease cloud spending.

- **Investment**

An action that will increase cloud spending.

cumulative

Default: false.

When true, shows the savings for each action in a scope as a cumulative total, rather than showing the savings for individual actions.

environmentType

- **ONPREM:**

Returns only actions related to entities that are part of your on-premises environment.

- **CLOUD:**

Returns only actions related to entities that are part of your cloud environment.

groupBy

You may group the actions returned by the following criteria: [actionModes, actionStates, actionTypes, risk, riskSeverity, riskSubCategory]

hasReservedInstance

Default: false.

When true, only actions that are related to reserved instances will be returned.

relatedEntityTypes

Returns only actions related to entities of these types within the scope. For example, if your scope is a virtual datacenter and you specify VirtualMachine as a related entity type, the request will include only those actions related to VMs in the specified virtual datacenter.

Choose from the following entity types: [Datacenter, PhysicalMachine, VirtualMachine, Storage, Application, Chassis, DiskArray, IOModule, StorageControl, Switch, VirtualDataCenter, VPod, DPod, Container, Database, DatabaseServerContainer, LogicalPool]

riskSeverityList

Returns only actions of the given severities: [Unknown, Normal, Minor, Major, Critical]

riskSubCategoryList

returns only actions of the given subcategories: [Performance Assurance, Efficiency Improvement, Prevention, Compliance]

The following commodities may be returned as the related commodity for an action:

Access
ActionPermit
ActiveSessions
ApplicationCommodity
Ballooning
Biclique
BufferCommodity
BurstBalance
CPU
CPUAllocation
CPUProvisioned
ClusterCommodity
CollectionTime
Connection
Cooling
Coupon
CrossCloudMoveSvc
CrossClusterMoveSvc
DBCacheHitRate
DBMem
DISK_ARRAY_ACCESS
DSPMAccessCommodity
DataCenterCommodity
DatastoreCommodity
DrsSegmentationCommodity
Extent
Flow
FlowAllocation
HACommodity
HOST_LUN_ACCESS
Heap
HotStorage
IOThroughput
ImageCPU
ImageMem
ImageStorage
InstanceDiskSize
InstanceDiskType
LICENSE_ACCESS
LicenseCommodity
Mem
MemAllocation
MemProvisioned
Move

NetThroughput
NetworkCommodity
NetworkInterfaceCount
NetworkPolicy
NumDisk
NumberConsumers
NumberConsumersPM
NumberConsumersStorage
PORT_CHANNEL
PoolCPU
PoolMem
PoolStorage
Power
ProcessingUnits
Q1VCPUs
Q2VCPUs
Q3VCPUs
Q4VCPUs
Q5VCPUs
Q6VCPUs
Q7VCPUs
Q8VCPUs
Q16VCPUs
Q32VCPUs
Q64VCPUs
QNVCPUs
ResponseTime
RightSizeDown
RightSizeSVC
RightSizeUp
SLACommodity
SameClusterMoveSvc
SegmentationCommodity
ServiceLevelCluster
SoftwareLicenseCommodity
Space
Storage
StorageAccess
StorageAllocation
StorageAmount
StorageClusterCommodity
StorageLatency
StorageProvisioned
Swapping
TemplateAccess
TenancyAccess
Threads
Transaction
TransactionLog
Unknown
VAppAccess

VCPU
VCPULimitQuota
VCPURequest
VCPURequestQuota
VDCCommodity
VMPMAccessCommodity
VMem
VMemLimitQuota
VMemRequest
VMemRequestQuota
VStorage
Zone

Example: POST <https://10.10.10.10/api/v3/actions>

Example input: In this example, a list of actions that meet the following criteria will be returned and grouped by the `actionMode` of the action:

- Is in state `PENDING_ACCEPT`
- Is part of an on-premises environment
- Is an action for a virtual machine
- Is an action generated by the Turbonomic real-time market

```
{
  "actionInput": {
    "actionStateList": [
      "PENDING_ACCEPT"
    ],
    "environmentType": "ONPREM",
    "groupBy": [
      "actionModes"
    ]
  },
  "relatedType": "VirtualMachine",
  "scopes": [
    "Market"
  ]
}
```

Response: A list of `ActionApiDTOs` that meet the specified criteria.

Accepting or Rejecting a Specified Action

This request accepts or rejects an action with the specified UUID, and takes the following parameters:

action_UUID (Required)

The UUID of the action.

accept (Required)

When `true`, accepts the action. When `false`, rejects the action.

Example: POST https://10.10.10.10/api/v3/actions/_QJCzNd3JEej-LI4LMER0w?accept=false

Response: `true`, if the action was accepted.

Actions Endpoint Tips

GroupBy Field Criteria

When using the POST requests to query actions and action statistics, there is a `groupBy` parameter that you may use to group statistics. The valid values for this parameter differ by entity type. Here is the complete list of valid options per entity:

Note:

When sending an inputDTO using this field, only the value is needed.

Example: `"groupBy": "vmsByPMName"`

```
{
  "VirtualMachine": {
    "criteria": [
      {
        "filterType": "vmsByName"
      },
      {
        "filterType": "vmsByPMName"
      },
      {
        "filterType": "vmsByStorage"
      },
      {
        "filterType": "vmsByNetwork"
      },
      {
        "filterType": "vmsByApplication"
      },
      {
        "filterType": "vmsByDatabaseServer"
      },
      {
        "filterType": "vmsByDatabaseServerVersion"
      },
      {
        "filterType": "vmsByDC"
      },
      {
        "filterType": "vmsByVDC"
      },
      {
        "filterType": "vmsByDCnested"
      },
      {
        "filterType": "vmsByNumCPUs"
      },
      {
        "filterType": "vmsByMem"
      },
      {
        "filterType": "vmsByGuestName"
      },
      {
        "filterType": "vmsByAltName"
      },
      {
        "filterType": "vmsByClusterName"
      },
      {
        "filterType": "vmsByDiskArrayName"
      },
      {
        "filterType": "vmsByLogicalPoolName"
      },
      {
        "filterType": "vmsByProfileName"
      },
      {
        "filterType": "vmsByTag"
      },
      {
        "filterType": "vmsByState"
      }
    ]
  }
}
```



```

    {
      "filterType": "vmsByBusinessAccountUuid"
    },
    {
      "filterType": "vmsByResourceGroupUuid"
    }
  ],
  "VirtualDataCenter": {
    "criteria": [
      {
        "filterType": "vdcsByName"
      },
      {
        "filterType": "vdcsByVDCName"
      },
      {
        "filterType": "vdcsByTag"
      },
      {
        "filterType": "vdcsByState"
      }
    ]
  },
  "PhysicalMachine": {
    "criteria": [
      {
        "filterType": "pmsByName"
      },
      {
        "filterType": "pmsByStorage"
      },
      {
        "filterType": "pmsByNetwork"
      },
      {
        "filterType": "pmsBySwitch"
      },
      {
        "filterType": "pmsByNumVms"
      },
      {
        "filterType": "pmsByDC"
      },
      {
        "filterType": "pmsByMem"
      },
      {
        "filterType": "pmsByNumCPUs"
      },
      {
        "filterType": "pmsByVendorName"
      },
      {
        "filterType": "pmsByCPUModel"
      },
      {
        "filterType": "pmsByModel"
      },
      {
        "filterType": "pmsByTimezone"
      },
      {
        "filterType": "pmsByClusterName"
      },
      {
        "filterType": "pmsByTag"
      },
      {
        "filterType": "pmsByState"
      }
    ]
  },
  "Storage": {
    "criteria": [
      {
        "filterType": "storageByName"
      },
      {
        "filterType": "storageByTag"
      }
    ]
  }
}

```

```

        "filterType": "storageByVMs"
      },
      {
        "filterType": "storageByDC"
      },
      {
        "filterType": "storageByPMCluster"
      },
      {
        "filterType": "storageByState"
      }
    ]
  },
  "Application": {
    "criteria": [
      {
        "filterType": "appsByName"
      },
      {
        "filterType": "appsByTag"
      }
    ]
  },
  "ApplicationComponent": {
    "criteria": [
      {
        "filterType": "appSrvsByName"
      }
    ]
  },
  "WebServer": {
    "criteria": [
      {
        "filterType": "wbSrvsByName"
      }
    ]
  },
  "BusinessApplication": {
    "criteria": [
      {
        "filterType": "busAppsByName"
      }
    ]
  },
  "Database": {
    "criteria": [
      {
        "filterType": "databaseByName"
      },
      {
        "filterType": "databaseByTag"
      },
      {
        "filterType": "databaseByBusinessAccountUuid"
      },
      {
        "filterType": "databaseByResourceGroupUuid"
      }
    ]
  },
  "DatabaseServer": {
    "criteria": [
      {
        "filterType": "databaseServerByName"
      },
      {
        "filterType": "databaseServerByTag"
      },
      {
        "filterType": "databaseServerByBusinessAccountUuid"
      },
      {
        "filterType": "databaseServerByEngine"
      },
      {
        "filterType": "databaseServerByEdition"
      },
      {
        "filterType": "databaseServerByVersion"
      }
    ]
  }
},

```

```

"VirtualApplication":{
  "criteria":[
    {
      "filterType":"vappsByName"
    }
  ]
},
"Cluster":{
  "criteria":[
    {
      "filterType":"clustersByName"
    },
    {
      "filterType":"clustersByTag"
    }
  ]
},
"DataCenter":{
  "criteria":[
    {
      "filterType":"datacentersByName"
    },
    {
      "filterType":"datacentersByTag"
    }
  ]
},
"Group":{
  "criteria":[
    {
      "filterType":"groupsByName"
    },
    {
      "filterType":"groupsByTargetName"
    }
  ]
},
"StorageCluster":{
  "criteria":[
    {
      "filterType":"storageClustersByName"
    }
  ]
},
"DiskArray":{
  "criteria":[
    {
      "filterType":"diskarrayByName"
    }
  ]
},
"Zone":{
  "criteria":[
    {
      "filterType":"zonsByName"
    }
  ]
},
"Region":{
  "criteria":[
    {
      "filterType":"regsByName"
    }
  ]
},
"Network":{
  "criteria":[
    {
      "filterType":"netsByName"
    }
  ]
},
"LoadBalancer":{
  "criteria":[
    {
      "filterType":"lbsByName"
    }
  ]
},
"Chassis":{
  "criteria":[
    {

```

```

        "filterType": "chasByName"
    }
}
},
"IOModule": {
    "criteria": [
        {
            "filterType": "ioModuleByName"
        }
    ]
},
"StorageController": {
    "criteria": [
        {
            "filterType": "storagecontrollerByName"
        }
    ]
},
"DPod": {
    "criteria": [
        {
            "filterType": "dpodByName"
        }
    ]
},
"VPod": {
    "criteria": [
        {
            "filterType": "vpodByName"
        }
    ]
},
"LogicalPool": {
    "criteria": [
        {
            "filterType": "logicalPoolByName"
        }
    ]
},
"Switch": {
    "criteria": [
        {
            "filterType": "switchByName"
        }
    ]
},
"Container": {
    "criteria": [
        {
            "filterType": "containersByName"
        },
        {
            "filterType": "containersByVMName"
        }
    ]
},
"ContainerPod": {
    "criteria": [
        {
            "filterType": "containerpodsByName"
        },
        {
            "filterType": "containerpodsByVMName"
        }
    ]
},
"ServiceEntity": {
    "criteria": [
        {
            "filterType": "workloadByBusinessAccountUuid"
        },
        {
            "filterType": "workloadByResourceGroupUuid"
        }
    ]
},
"Workload": {
    "criteria": [
        {
            "filterType": "workloadByBusinessAccountUuid"
        }
    ]
}
}

```

```

        "filterType": "workloadByResourceGroupUuid"
    }
  ],
  "ResourceGroup": {
    "criteria": [
      {
        "filterType": "resourceGroupByName"
      },
      {
        "filterType": "resourceGroupByUuid"
      },
      {
        "filterType": "resourceGroupByBusinessAccountUuid"
      },
      {
        "filterType": "resourceGroupByTag"
      }
    ]
  },
  "BusinessAccount": {
    "criteria": [
      {
        "filterType": "businessAccountByName"
      },
      {
        "filterType": "businessAccountByUuid"
      },
      {
        "filterType": "subBusinessAccountOfUuid"
      },
      {
        "filterType": "businessAccountValidationStatus"
      },
      {
        "filterType": "businessAccountTargetName"
      },
      {
        "filterType": "businessAccountCloudProvider"
      }
    ]
  },
  "BillingFamily": {
    "criteria": [
      {
        "filterType": "billingFamilyByName"
      }
    ]
  },
  "ViewPod": {
    "criteria": [
      {
        "filterType": "viewPodByName"
      }
    ]
  },
  "DesktopPool": {
    "criteria": [
      {
        "filterType": "desktopPoolByName"
      },
      {
        "filterType": "desktopPoolByViewPod"
      }
    ]
  },
  "BusinessUser": {
    "criteria": [
      {
        "filterType": "businessUserByName"
      },
      {
        "filterType": "businessUserByDesktopPool"
      }
    ]
  }
}

```

Admin Endpoint

The admin endpoint is a collection of requests that enable you to perform various administrative functions. To use the admin endpoint, you must be logged into Turbonomic as an administrator user.

Using the admin endpoint, you can:

- Load existing configuration files for use in your environment
- Export diagnostics locally, and send them to Support
- Get or set proxy settings
- Get or set logging levels for various components of your environment
- Get the current product version information
- Check for and apply updates to your Turbonomic appliance

Admin Requests

Getting the Current Version

Gets the version of each Turbonomic package that your instance is running. Set the `check_for_updates` parameter to `true` to additionally check for updates that may be available.

This request takes the following parameters:

check_for_updates

Check for available updates before returning version information. Default: `false`.

Example: GET `https://10.10.10.10/api/v3/admin/versions?check_for_updates=true`

Response: A `ProductVersionDTO` describing details about the current version and available updates. If you are running the latest version of Turbonomic, the updates value will read "No Updates Available\n"

```
{
  "versionInfo": "Turbonomic Operations Manager 6.1.7 (Build 20180813223950000)\nvmt-
platform-6.1.7-20180813223950000.i586
  ...
  "updates": "Available Packages\nvmt-bundle.i586 6.2.0-20180817180112000 vmturbo\nvmt-
config.x86_64
  ...
  "marketVersion": 2
}
```

Exporting Diagnostics

If you are experiencing problems with Turbonomic, your support engineer might request that you export diagnostic data. You can export the data and then send it to the support engineer as requested.

Example: POST `https://10.10.10.10/api/v3/admin/exports`

Response: `true` if successful, `false` if an error occurs while creating the export. The export file will be saved in the `/tmp` directory on your instance with a file name that begins with `bkp-`.

Loading External Configuration Files

To help with diagnosis of some issues, a support engineer might want you to load configuration files into your Turbonomic appliance. You should only use this request while working with a support engineer, who will guide you through the process. Using the required parameters, the support engineer will specify what kind of configuration file you are loading, and the contents of that file.

Example: POST `https://10.10.10.10/api/v3/admin/configfiles?config_type=TOPOLOGY&topology=abc`

Response: `true` if successful, `false` if an error occurs while uploading the configuration.

Getting and Setting a Proxy

Gets the current state of the proxy and proxy details (if enabled).

Example: GET `https://10.10.10.10/api/v3/admin/httpproxy`

Response: A `HttpProxyDTO` describing details of the proxy. If no proxy is configured, this request returns `"isProxyEnabled": false`.

```
{
  "isProxyEnabled": true,
  "proxyHost": "10.10.111.1",
  "userName": "UserName",
  "password": "PW"
}
```

To set the proxy, pass a `HttpProxyDTO`, making sure to include `"isProxyEnabled": true` if you want to activate the proxy immediately.

Example: POST `https://10.10.10.10/api/v3/admin/httpproxy`

Example `httpProxyDTO`:

```
{
  "isProxyEnabled": true,
  "proxyHost": "10.10.111.1",
  "portNumber": "33128",
  "userName": "ProxyUser",
  "password": "Password"
}
```

Response: `true` if successful, `false` if an error occurs while setting the proxy.

Getting and Setting Logging Levels by Component

You can set the level of logging for different components of the Turbonomic platform. The default logging level for all components is `INFO`. You should be aware that setting more verbose logging levels may greatly increase the disk space required to store the log files. You normally change these settings only while you're working with a Turbonomic support engineer.

The available logging levels are (in order of least to most verbose): `INFO`, `WARN`, `DEBUG`, and `TRACE`.

Example: GET `https://10.10.10.10/api/v3/admin/logginglevels`

Response: A `LoggingApiDTO` with details about your current logging level settings:

```
{
  "componentLoggingLevel": {
    "Extension": "INFO",
    "Analysis": "INFO",
    "Discovery": "INFO",
    "API": "INFO",
    "Presentation": "INFO",
    "Abstraction": "INFO",
    "Monitoring": "INFO"
  }
}
```

To set the logging level for a specific component, pass a partial `LoggingApiDTO` containing the component and logging level.

Example: POST `https://10.10.10.10/api/v3/admin/logginglevels`

Example LoggingApiDTO:

```
{
  "componentLoggingLevel": {
    "Extension": "WARN"
  }
}
```

Response: A successful response returns your input in the response body.

Businessunits Endpoint

Business units are container objects used for modeling accounts and subscriptions in Public Cloud targets, and for cloud budgets and price adjustments.

Using the businessunits endpoint of the Turbonomic API, you can:

- For a specified business unit, get a list of:
 - All actions relating to the entities in the business unit
 - Cloud services and pricing models
 - All entities belonging to the business unit
 - Price adjustments
 - Any related (parent, sibling, or child) business units
 - Statistics relating to entities in the business unit
 - Templates available
- Get the supply chain for a specified business unit
- Create a business unit
- Edit a business unit
- Edit a price adjustment
- Delete a business unit

Business units may be one of three types, described below:

BUDGET

A business unit that has a budget, and may contain children.

DISCOUNT

A business unit that has a discount, and may contain children.

DISCOVERED

A business unit that has been discovered by the Turbonomic instance. These business units should not be edited or deleted, except on the discovered target.

Businessunits Requests

Getting Business Units

Gets a list of all business units created on or discovered by your Turbonomic instance. This request takes the following parameters:

type

The type of business unit to return. [BUDGET, DISCOUNT, DISCOVERED]

cloud_type

The cloud provider whose business units to return. [AWS, AZURE, GCP]

has_parent

Whether to return only business units that have parent business units. Default: False. When true, all relevant business units will be returned irrespective of parent business units.

Example: GET https://10.10.10.10/api/v3/businessunits?type=DISCOVERED&cloud_type=AWS

Response: A list of BusinessUnitApiDTOs that meet the selected criteria. In this case, discovered business units that are part of an AWS environment.

```
[
  {
    "uuid": "323871187550",
    "displayName": "Product Trust",
    "className": "BusinessAccount",
    "environmentType": "CLOUD",
    "master": false,
    "hasRelatedTarget": true,
    "budget": {
      "value": 0
    },
    "businessUnitType": "DISCOVERED",
    "cloudType": "AWS",
    "targets": [
      {
        "uuid": "_6glgQEEhEemQ645gSx8RYw",
        "displayName": "PT-AWS",
        "type": "AWS"
      }
    ],
    "costPrice": 0,
    "severity": "Critical",
    "membersCount": 80,
    "memberType": "Workload",
    "related": {
      "rateCard": null,
      "priceAdjustment": null
    },
    "resourceGroupsCount": 0
  },
  {
    "uuid": "001844731978",
    "displayName": "Advanced Engineering",
    "className": "BusinessAccount",
    "environmentType": "CLOUD",
    "master": false,
    "hasRelatedTarget": false,
    "budget": {
      "value": 0
    },
    "businessUnitType": "DISCOVERED",
    "cloudType": "AWS",
    "costPrice": 0,
    "severity": "Normal",
    "membersCount": 0,
    "memberType": "Workload",
    "related": {
      "rateCard": null,
      "priceAdjustment": null
    },
    "resourceGroupsCount": 0
  },
  {
    "uuid": "192821421245",
    "displayName": "Development",
    "className": "BusinessAccount",
    "environmentType": "CLOUD",
    "master": true,
    "hasRelatedTarget": true,
    "budget": {
      "value": 0
    },
    "businessUnitType": "DISCOVERED",
    "cloudType": "AWS",
    "childrenBusinessUnits": [
      "631949720430",
      "001844731978",
      "323871187550"
    ]
  }
]
```

```

],
"targets": [
  {
    "uuid": "_cBVj0MvWEeiFJej-UwMSGg",
    "displayName": "engineering.aws.amazon.com",
    "type": "AWS"
  }
],
"costPrice": 0,
"severity": "Critical",
"membersCount": 33,
"memberType": "Workload",
"related": {
  "rateCard": null,
  "priceAdjustment": null
},
"resourceGroupsCount": 0
},
{
  "uuid": "631949720430",
  "displayName": "Turbonomic SaaS",
  "className": "BusinessAccount",
  "environmentType": "CLOUD",
  "master": false,
  "hasRelatedTarget": false,
  "budget": {
    "value": 0
  },
  "businessUnitType": "DISCOVERED",
  "cloudType": "AWS",
  "costPrice": 0,
  "severity": "Normal",
  "membersCount": 0,
  "memberType": "Workload",
  "related": {
    "rateCard": null,
    "priceAdjustment": null
  },
  "resourceGroupsCount": 0
}
]

```

Deleting a Business Unit

To delete a business unit, pass the UUID of the business unit in the request. Note, you cannot delete DISCOVERED business units.

Example: DELETE <https://10.10.10.10/api/v3/businessunits/49d50ac3f8adbfe649d53e72c42dd9428d1d3835>

Response: A response of 200 indicates successful deletion

Getting Cloud Service and Pricing Model Pairs for a Specified Business Unit

Gets the cloud service name and pricing model for each cloud service.

Example: GET <https://10.10.10.10/api/v3/businessunits/192821421245/cloudservices>

Response: A list of CloudServicePricingModelApiDTOs representing each cloud service available to the business unit:

```

[
  {
    "uuid": "aws::631949720430::CS::AWSCloudTrail",
    "displayName": "AWS CloudTrail",
    "pricingModel": "ON_DEMAND"
  },
  {
    "uuid": "aws::631949720430::CS::AmazonCloudWatch",
    "displayName": "AWS CloudWatch",
    "pricingModel": "ON_DEMAND"
  },
  {
    "uuid": "aws::192821421245::CS::AWSDeveloperSupport",

```

```

    "displayName": "AWS Developer Support",
    "pricingModel": "ON_DEMAND"
  },
  {
    "uuid": "aws::001844731978::CS::AmazonDynamoDB",
    "displayName": "AWS DynamoDB",
    "pricingModel": "ON_DEMAND"
  },
  {
    "uuid": "aws::631949720430::CS::AmazonEC2",
    "displayName": "AWS EC2",
    "pricingModel": "ON_DEMAND"
  },
  {
    "uuid": "aws::001844731978::CS::AmazonEKS",
    "displayName": "AWS EKS",
    "pricingModel": "ON_DEMAND"
  },
  ...
]

```

Getting Price Adjustments Related to a Specified Business Unit

Gets any price adjustments affecting the specified business unit.

Example: GET <https://10.10.10.10/api/v3/businessunits/192821421245/priceadjustments>

Response: A list of BusinessUnitPriceAdjustmentApiDTOs showing the corrected prices after adjustment:

```

[
  {
    "servicePriceAdjustments": [
      {
        "uuid": "aws::192821421245::CS::AmazonCloudWatch",
        "displayName": "AWS CloudWatch",
        "pricingModel": "ON_DEMAND"
      },
      {
        "uuid": "aws::192821421245::CS::AWSDeveloperSupport",
        "displayName": "AWS Developer Support",
        "pricingModel": "ON_DEMAND"
      },
      {
        "uuid": "aws::192821421245::CS::AmazonDynamoDB",
        "displayName": "AWS DynamoDB",
        "pricingModel": "ON_DEMAND"
      },
      {
        "uuid": "aws::192821421245::CS::AmazonEC2",
        "displayName": "AWS EC2",
        "pricingModel": "ON_DEMAND",
        "templateDiscounts": [
          {
            "uuid": "aws::VMPROFILE::g3.16xlarge",
            "displayName": "g3.16xlarge",
            "family": "g3",
            "pricesPerDatacenter": [
              {
                "uuid": "aws::ap-southeast-1::DC::ap-southeast-1",
                "displayName": "aws-Asia Pacific (Singapore)",
                "price": 6.68
              },
              {
                "uuid": "aws::us-west-2::DC::us-west-2",
                "displayName": "aws-US West (Oregon)",
                "price": 4.56
              },
              {
                "uuid": "aws::ca-central-1::DC::ca-central-1",
                "displayName": "aws-Canada (Central)",
                "price": 5.664
              }
            ]
          },
          {
            "uuid": "aws::eu-west-1::DC::eu-west-1",

```

```

        "displayName": "aws-EU (Ireland)",
        "price": 4.84
    },
    {
        "uuid": "aws::eu-west-3::DC::eu-west-3",
        "displayName": "aws-EU (Paris)",
        "price": 0
    },
    {
        "uuid": "aws::ap-northeast-1::DC::ap-northeast-1",
        "displayName": "aws-Asia Pacific (Tokyo)",
        "price": 6.32
    },
    {
        "uuid": "aws::eu-central-1::DC::eu-central-1",
        "displayName": "aws-EU (Frankfurt)",
        "price": 5.7
    },
    {
        "uuid": "aws::ap-south-1::DC::ap-south-1",
        "displayName": "aws-Asia Pacific (Mumbai)",
        "price": 0
    },
    {
        "uuid": "aws::ap-northeast-2::DC::ap-northeast-2",
        "displayName": "aws-Asia Pacific (Seoul)",
        "price": 0
    },
    {
        "uuid": "aws::us-east-1::DC::us-east-1",
        "displayName": "aws-US East (N. Virginia)",
        "price": 4.56
    },
    {
        "uuid": "aws::us-west-1::DC::us-west-1",
        "displayName": "aws-US West (N. California)",
        "price": 6.136
    },
    {
        "uuid": "aws::sa-east-1::DC::sa-east-1",
        "displayName": "aws-South America (Sao Paulo)",
        "price": 0
    },
    {
        "uuid": "aws::ap-southeast-2::DC::ap-southeast-2",
        "displayName": "aws-Asia Pacific (Sydney)",
        "price": 7.016
    },
    {
        "uuid": "aws::us-east-2::DC::us-east-2",
        "displayName": "aws-US East (Ohio)",
        "price": 4.56
    },
    {
        "uuid": "aws::eu-north-1::DC::eu-north-1",
        "displayName": "aws-EU (Stockholm)",
        "price": 0
    },
    {
        "uuid": "aws::eu-west-2::DC::eu-west-2",
        "displayName": "aws-EU (London)",
        "price": 0
    }
    ]
},
{
    "uuid": "aws::VMPROFILE::p3.8xlarge",
    "displayName": "p3.8xlarge",
    "family": "p3",
    "pricesPerDatacenter": [
        {
            "uuid": "aws::ap-southeast-1::DC::ap-southeast-1",
            "displayName": "aws-Asia Pacific (Singapore)",
            "price": 16.936
        },
        {
            "uuid": "aws::us-west-2::DC::us-west-2",
            "displayName": "aws-US West (Oregon)",
            "price": 12.24
        },
        {
            "uuid": "aws::ca-central-1::DC::ca-central-1",

```

```

        "displayName": "aws-Canada (Central)",
        "price": 13.464
      },
      {
        "uuid": "aws::eu-west-1::DC::eu-west-1",
        "displayName": "aws-EU (Ireland)",
        "price": 13.22
      },
      {
        "uuid": "aws::eu-west-3::DC::eu-west-3",
        "displayName": "aws-EU (Paris)",
        "price": 0
      },
      {
        "uuid": "aws::ap-northeast-1::DC::ap-northeast-1",
        "displayName": "aws-Asia Pacific (Tokyo)",
        "price": 16.776
      },
      {
        "uuid": "aws::eu-central-1::DC::eu-central-1",
        "displayName": "aws-EU (Frankfurt)",
        "price": 15.292
      },
      {
        "uuid": "aws::ap-south-1::DC::ap-south-1",
        "displayName": "aws-Asia Pacific (Mumbai)",
        "price": 0
      },
      {
        "uuid": "aws::ap-northeast-2::DC::ap-northeast-2",
        "displayName": "aws-Asia Pacific (Seoul)",
        "price": 16.936
      },
      ...
    ]
  }
]

```

Editing Price Adjustments of a Specified Business Unit

To edit a price adjustment for the specified business unit, send a `BusinessUnitPriceAdjustmentApiDTO` with the corrected information (in this case, changing the percent discount from 25 to 50).

Example: PUT <https://10.10.10.10/api/v3/businessunits/c0acb428d7b447a5d51f9888d2b6660b5fa5225f>

Example Input:

```

{
  "name": "Daltest1",
  "priceAdjustment": {
    "type": "DISCOUNT",
    "value": 50
  },
  "childrenBusinessUnits": [
    "192821421245"
  ],
  "businessUnitType": "DISCOUNT",
  "uuid": "c0acb428d7b447a5d51f9888d2b6660b5fa5225f"
}

```

Response: The full `BusinessUnitPriceAdjustmentApiDTO` with the corrected values:

```

{
  "uuid": "c0acb428d7b447a5d51f9888d2b6660b5fa5225f",
  "displayName": "Daltest1",
  "className": "BusinessAccount",
  "environmentType": "CLOUD",
  "discount": 50,

```

```

    "priceAdjustment": {
      "type": "DISCOUNT",
      "value": 50
    },
    "master": false,
    "hasRelatedTarget": false,
    "budget": {
      "value": 0
    },
    "businessUnitType": "DISCOUNT",
    "cloudType": "AWS",
    "childrenBusinessUnits": [
      "192821421245"
    ],
    "costPrice": 0,
    "severity": "Normal",
    "membersCount": 0,
    "memberType": "Workload",
    "related": {
      "rateCard": null,
      "priceAdjustment": {
        "uuid": "c0acb428d7b447a5d51f9888d2b6660b5fa5225f",
        "displayName": "Daltest1",
        "className": "BusinessAccount"
      }
    },
    "resourceGroupsCount": 0
  }
}

```

Getting Templates Available to a Business Unit

Referenced Endpoint: [Templates](#)

Gets details about each template available to the specified business unit:

Example: GET <https://10.10.10.10/api/v3/businessunits/192821421245/templates>

Response: A list of TemplateApiDTOs representing the available templates for the specified business unit:

```

[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/templates/B4166E9F-589B-357D-AC74-0A534B53CE85"
      }
    ],
    "uuid": "B4166E9F-589B-357D-AC74-0A534B53CE85",
    "displayName": "db.x1e.32xlarge",
    "className": "DatabaseServerProfile",
    "price": 0,
    "model": "db.x1e.32xlarge",
    "dbEngine": "Oracle",
    "dbEdition": "Enterprise",
    "computeResources": [
      {
        "stats": [
          {
            "name": "numOfCpu",
            "value": 128
          },
          {
            "name": "cpuSpeed",
            "units": "MHz",
            "value": 384000
          },
          {
            "name": "ioThroughputSize",
            "units": "MB/s",
            "value": 546.875
          },
          {
            "name": "memorySize",
            "units": "MB",
            "value": 3997696
          }
        ]
      }
    ]
  }
]

```

```

    }
  ]
},
"storageResources": [
  {
    "stats": [
      {
        "name": "diskSize",
        "units": "GB",
        "value": 3840
      },
      {
        "name": "diskIops",
        "value": 35000
      }
    ]
  }
],
"deploymentProfile": {
  "uuid": "5C57DCA5-72AB-34BF-A22D-06719D13182E",
  "displayName": "DEP-RDB-'ap-northeast-1'",
  "className": "ServiceCatalogItem",
  "deployParameters": [
    {
      "targetType": "AWS",
      "providers": [
        {
          "provider": {
            "discoveredBy": {
              "uuid": "_RRn00PMSEeisB7K_chUWVw",
              "displayName": "vmturbodev.aws.amazon.com",
              "type": "AWS"
            }
          }
        }
      ]
    }
  ]
},
"discovered": true
},
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/templates/aws::VMPROFILE::g3.16xlarge"
    }
  ],
  "uuid": "aws::VMPROFILE::g3.16xlarge",
  "displayName": "g3.16xlarge",
  "className": "VirtualMachineProfile",
  "description": "g3.16xlarge",
  "computeResources": [
    {
      "stats": [
        {
          "name": "ioThroughputSize",
          "units": "MB/s",
          "value": 1750
        },
        {
          "name": "networkThroughputSize",
          "units": "MB/s",
          "value": 2500
        },
        {
          "name": "numOfCpu",
          "value": 64
        },
        {
          "name": "cpuSpeed",
          "units": "MHz",
          "value": 6664.6587
        },
        {
          "name": "cpuConsumedFactor",
          "units": "%",
          "value": 50
        },
        {
          "name": "memorySize",

```

```

        "units": "MB",
        "value": 499712
      },
      {
        "name": "memoryConsumedFactor",
        "units": "%",
        "value": 75
      },
      {
        "name": "ioThroughput",
        "units": "MB/s",
        "value": 0
      },
      {
        "name": "networkThroughput",
        "units": "MB/s",
        "value": 0
      }
    ]
  },
  "storageResources": [
    {
      "stats": [
        {
          "name": "diskSize",
          "units": "GB",
          "value": 976562.5
        },
        {
          "name": "diskIops",
          "value": 20000
        },
        {
          "name": "diskConsumedFactor",
          "units": "%",
          "value": 100
        }
      ]
    }
  ],
  "deploymentProfile": {
    "uuid": "aws:us-east-1:DP::DEP-fake-us-east-1",
    "displayName": "DEP-fake-us-east-1",
    "className": "ServiceCatalogItem",
    "deployParameters": [
      {
        "targetType": "AWS",
        "providers": [
          {
            "provider": {
              "discoveredBy": {
                "uuid": "_RRn00PMSEeisB7K_chUWVw",
                "displayName": "vmturbodev.aws.amazon.com",
                "type": "AWS"
              }
            }
          }
        ]
      }
    ]
  },
  "discovered": true,
  "family": "g3"
},
...
]

```

Entities Endpoint

Entities are the objects in your topology that Turbonomic manages. For example, VMs, hosts, datastores, and applications are all entities. Turbonomic discovers entities via targets, it monitors and analyzes their utilization of resources, and it recommends actions to change the placement, configuration, or state of entities.

Each market manages a set of entities. Using a market's UUID, you can get a list of entities managed by that market. For each entity you can get a full range of data, including the resources it buys and sells, the providers it buys resources from, actions for the entity, and other associated information.

Remember that more than one market can be resident in memory at a given time — Turbonomic maintains a real-time market, and there can also be plan markets in memory. As you access market entities, you should keep the following in mind:

- Entities in the real-time market reflect the current state in your physical environment
- You should never add or remove entities in the real-time market
- Entities in a plan market reflect a snapshot of the environment from when the market was created
- Plan markets can be scoped to a subset of your physical environment
- You *can* add or remove entities in a plan market

An interesting point about entities and markets — A plan market can contain entities that are also managed by the real-time market. These entities have the same stats in both markets. Turbonomic independently performs analysis on these entities in both markets.

Using the entities endpoint of the Turbonomic API, you can get a list of entities (from the market or group that contains the entities). For an individual entity you can get:

- Actions and related data for an entity
- Constraints assigned to the entity
- Through the entity constraints, get the available providers and consumers for the entity
- Groups the entity belongs to
- Notifications and notification data
- Workload placement policies that affect this entity
- Automation policies that affect this entity
- Stats for the entity
- The supply chain of entities that stitch directly with this entity
- Any tags that are defined for the entity

This endpoint contains references to start and end times for certain operations. For more information, including valid time formats, see [Time in the Turbonomic API](#)

Entities Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble inputDTOs, or see the potential values of a particular DTO.

Getting a List of Entry Points for Entities

The entities endpoint contains a utility request that shows the entry points you can use to get lists of entities. These can be used to find the UUID and details relating to specific entities.

Example: GET <https://10.10.10.10/api/v3/entities>

Response: An array of Link objects, where each object contains a URL to get all entities for a specified market or group.

```
{
  "links": [
    {
      "rel": "Market actions",
      "href": "https://10.10.10.10/api/v3/markets/{uuid}/entities"
    },
    {
      "rel": "Group actions",
      "href": "https://10.10.10.10/api/v3/groups/{uuid}/entities"
    }
  ]
}
```

```
]
}
```

Getting a List of Entry Points for a Single Entity

If you pass an entity UUID to the entities endpoint, then you get a description of the entity, plus a list of entry points for entity data such as stats, constraints, actions, etc.

Example: GET <https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073>

Response: An array of Link objects, where each object contains a URL to get information about the entity.

```
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073?include_aspects=false"
    },
    {
      "rel": "To Stats",
      "href": "https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/stats"
    },
    {
      "rel": "Entity notifications",
      "href": "https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/notifications"
    },
    {
      "rel": "Entity actions",
      "href": "https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/actions?ascending=false"
    },
    {
      "rel": "To Constraints",
      "href": "https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/policies"
    },
    {
      "rel": "To Settings",
      "href": "https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/settings?include_settingspolicies=false"
    },
    {
      "rel": "To Entity List",
      "href": "https://10.10.10.10/api/v3/entities"
    }
  ],
  ...
}
```

Entities Requests

Getting Entities

Referenced Endpoint: [Groups](#)

To get a list of entities, start with the object that contains those entities. This is usually a market or a group. You work with individual entities via their UUIDs — A list of entities gives you a list of UUIDs that you can work with.

Note:

When working with groups, you should remember that a list of entities in the group is not the same as a list of group members. Assume a group of host clusters. In that case, the list of entities would be all the hosts in those clusters, while the group members would be a list of clusters, plus all the hosts in each cluster. For more information, see [Groups Endpoint](#).

Example: GET https://10.10.10.10/api/v3/groups/_BZbFswXUEemoItN1K8jw3Q/entities

```
[
  {
    "links": [
      ...
    ],
    "uuid": "azure::VM::2ffc038a-7af3-4d23-86a9-211da2e4d433",
    "displayName": "e47f9c97-b44d-4461-be02-0304b97e201e",
    "className": "VirtualMachine",
    "priceIndex": 1.0067123,
    "state": "ACTIVE",
    "severity": "Critical",
    "costPrice": 0.64534247,
    "discoveredBy": {
      "uuid": "_-S8GgFYoEemHGieet0B0nQ",
      "displayName": "758ad253-cbf5-4b18-8863-3eed0825bf07",
      "type": "Azure"
    },
    "remoteId": "azure::VM::2ffc038a-7af3-4d23-86a9-211da2e4d433",
    "providers": [
      {
        "uuid": "azure::ST::eastus2-managed_premium",
        "displayName": "azure-eastus2-Managed Premium",
        "className": "Storage"
      },
      {
        "uuid": "azure::eastus2::PM::eastus2",
        "displayName": "azure-eastus2",
        "className": "PhysicalMachine"
      }
    ],
    "consumers": [
      {
        "uuid": "azure::APP::2ffc038a-7af3-4d23-86a9-211da2e4d433",
        "displayName": "GuestLoad [e47f9c97-b44d-4461-be02-0304b97e201e]",
        "className": "Application"
      }
    ],
    "template": {
      "uuid": "azure::VMPROFILE::Standard_DS13_v2",
      "displayName": "Standard_DS13_v2",
      "discovered": false,
      "enableMatch": false
    },
    "environmentType": "CLOUD",
    "tags": {
      "instance_group": [
        "diego_cell"
      ]
    }
  },
  {
    ...
  }
]
```

Referenced Endpoint: Actions

This request takes the following parameters:

The UUID of the entity whose actions will be returned.

The UUID of the action you want to get – Required to get a single action.

cursor

When making subsequent calls to retrieve additional results, this is the cursor returned by the last call to this method.

limit

The maximum number of items to return. Must be a positive integer. If not set, the server will provide a default (20).

order_by

The field to order the results by. [creation_date, name, risk_category, savings, severity].

ascending

Default: true. When false, results will be in descending order.

Examples:

- Get a list of actions for the passed entity: GET https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/actions?order_by=severity&ascending=true
- Get a single action for the entity: GET <https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/actions/9223304219064809841>

Response: A list of ActionApiDTOs representing the actions that are current for the given entity, or a single ActionApiDTO for the specified action. The following listing shows the list of ActionApiDTOs wrapped in an array.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/actions/9223304219106592017"
      },
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/actions/2560158594896"
      }
    ],
    "uuid": "9223304219106592017",
    "createTime": "2019-04-23T10:41:37-04:00",
    "actionType": "RIGHT_SIZE",
    "actionState": "PENDING_ACCEPT",
    "actionMode": "MANUAL",
    "details": "Scale down VMem for VirtualMachine vEOS-4 from 2 GB to 623 MB",
    "importance": 0,
    "target": {
      "uuid": "420b1eeb-6190-a9d2-6436-4327ad3ac073",
      "displayName": "vEOS-4",
      "className": "VirtualMachine",
      "discoveredBy": {
        "uuid": "FJwg0EzHEmaXZFq01sC0g",
        "displayName": "vsphere-dc11.dev.mycorp.com",
        "type": "vCenter"
      }
    },
    "aspects": {
      "virtualMachineAspect": {
        "os": "Other 2.6.x Linux (32-bit)",
        "connectedNetworks": [
          {
            "uuid": "d2da5316adfff0bf779652bbe7eb76c3307c2ab5",
            "displayName": "Infrastructure"
          },
          {
            "uuid": "bbef68e6ee0e76ba2c82960012b4ba563b78fdbb",
            "displayName": "vmnet4"
          },
          {
            "uuid": "d59c5e7e738ad9d2e2cb45aac5fe0073d36b49fb",
            "displayName": "vmnet6"
          },
          {
            "uuid": "96a42a4d438d1336e8d2c6962c976d889792af8a",
            "displayName": "vmnet8"
          }
        ]
      }
    }
  }
]
```

```

        {
          "uuid": "067bc9d882e9681c55d964295e43134711520145",
          "displayName": "vmnet57"
        },
        {
          "uuid": "05b0ce5abc5cecc4104b26514b11618d77818c6d",
          "displayName": "vmnet59"
        }
      ],
      "numVCPUs": 1,
      "type": "VMEntityAspectApiDTO"
    }
  },
  "environmentType": "ONPREM"
},
"currentEntity": {
  "uuid": "_3vIfwmXVEemoItN1K8jw3Q",
  "className": "VMem"
},
"newEntity": {
  "uuid": "_5fnl82XVEemoItN1K8jw3Q",
  "className": "VMem",
  "aspects": {
    "virtualMachineAspect": {
      "os": "Linux (Free)",
      "type": "VMEntityAspectApiDTO"
    }
  }
},
"currentValue": "2097152.0",
"newValue": "637952.0",
"resizeToValue": "637952.0",
"risk": {
  "uuid": "_5fr3YWXVEemoItN1K8jw3Q",
  "subCategory": "Efficiency Improvement",
  "description": "Underutilized VMem in Virtual Machine 'vEOS-4'",
  "severity": "MINOR",
  "importance": 0,
  "reasonCommodity": "VMem"
},
"stats": [
  {
    "name": "costPrice",
    "filters": [
      {
        "type": "savingsType",
        "value": "savings"
      }
    ],
    "units": "$",
    "value": 69.58008
  }
],
"currentLocation": {
  "uuid": "98e12595449d993db8861c1f94c8f86ba277f17b",
  "displayName": "Cloud",
  "className": "DataCenter"
},
"newLocation": {
  "uuid": "98e12595449d993db8861c1f94c8f86ba277f17b",
  "displayName": "Cloud",
  "className": "DataCenter"
},
"actionID": 2560158594896
},
...
]

```

Getting a Filtered List of Actions Related to an Entity

Referenced Endpoint: [Actions](#)

Gets a list of actions, given a market UUID and filtered by an ActionApiInputDTO using one or more of the following criteria:

actionModeList

- **DISABLED:**
Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.
- **RECOMMENDED:**
Recommend the action so a user can execute it via the given hypervisor or by other external means
- **MANUAL:**
Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.
- **AUTOMATED:**
You have directed Turbonomic to execute the action automatically.
- **COLLECTION (UNUSED):**
Legacy action mode, no longer used.

actionStateList

- **DISABLED:**
An action whose policy has been disabled.
- **RECOMMEND:**
An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.
- **PENDING_ACCEPT:**
When the action mode is set to manual, a recommended action that has not been accepted or cleared.
- **ACCEPTED:**
An action that has been accepted, but is not yet in progress.
- **IN_PROGRESS:**
An action that is being executed.
- **SUCCEEDED:**
An action that was accepted and completed successfully.
- **FAILED:**
An action that was accepted and did not complete successfully.
- **REJECTED:**
When the action mode is set to manual, an action that has been rejected by the user.
- **CLEARED:**
When the action mode is set to manual, an action that is no longer recommended by the market.
- **ACCOUNTING:**
For cloud entities, an action to resize in order to use a different instance template.
- **QUEUED:**
When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

actionTypeList

- **START:**

Start an entity, and add it to the Turbonomic market.

- **MOVE:**

Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.

- **SUSPEND:**

Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.

- **ADD PROVIDER:**

This is equivalent to the START action, but for storage entities.

- **CHANGE:**

Move a virtual machine's storage between datastores.

- **PROVISION:**

Add capacity to your environment.

- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR_EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR_PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

cleared

Default: `false`.

When `true`, actions that were removed from the action list before being executed will be returned.

costType

- **Saving**

An action that will decrease cloud spending.

- **Investment**

An action that will increase cloud spending.

cumulative

Default: `false`.

When `true`, shows the savings for each action in a scope as a cumulative total, rather than showing the savings for individual actions.

environmentType

- ONPREM:
Returns only actions related to entities that are part of your on-premises environment.
- CLOUD:
Returns only actions related to entities that are part of your cloud environment.

groupBy

You may group the actions returned by the following criteria: [actionModes, actionStates, actionTypes, risk, riskSeverity, riskSubCategory]

hasReservedInstance

Default: false.

When true, only actions that are related to reserved instances will be returned.

relatedEntityTypes

Returns only actions related to entities of these types within the scope. For example, if your scope is a virtual datacenter and you specify VirtualMachine as a related entity type, the request will include only those actions related to VMs in the specified virtual datacenter.

Choose from the following entity types: [Datacenter, PhysicalMachine, VirtualMachine, Storage, Application, Chassis, DiskArray, IOModule, StorageControl, Switch, VirtualDataCenter, VPod, DPod, Container, Database, DatabaseServerContainer, LogicalPool]

riskSeverityList

Returns only actions of the given severities: [Unknown, Normal, Minor, Major, Critical]

riskSubCategoryList

returns only actions of the given subcategories: [Performance Assurance, Efficiency Improvement, Prevention, Compliance]

This request takes the following parameters:

entity_Uuid

The UUID of the market whose actions will be returned.

cursor

When making subsequent calls to retrieve additional results, this is the cursor returned by the last call to this method.

limit

The maximum number of items to return. Must be a positive integer. If not set, the server will provide a default (20).

order_by

The field to order the results by: [creation_date, name, risk_category, savings, severity].

ascending

Default: true. When false, results will be in descending order.

Example: POST https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/actions?order_by=severity&ascending=true

Example input: In this example, a list of actions that meet the following criteria will be returned and grouped by the actionMode of the action, in order of severity:

- Is in state PENDING_ACCEPT
- Is part of an on-premises environment

- Is an action for a virtual machine

```
{
  "actionInput": {
    "actionStateList": [
      "PENDING_ACCEPT"
    ],
    "environmentType": "ONPREM",
    "groupBy": [
      "actionModes"
    ]
  },
  "relatedType": "VirtualMachine",
  "scopes": [
    "Market"
  ]
}
```

Response: A list of ActionApiDTOs that meet the specified criteria.

Getting Statistics for a Filtered List of Actions Of an Entity

Referenced Endpoint: [Actions](#)

Referenced Endpoint: [Stats](#)

Gets a list of statistics for a filtered list of actions that are current for the passed entity. Statistics returned include the number of actions, total savings/investment, and the number of entities affected by the actions. In addition to the Entity UUID, provide an ActionApiInputDTO using one or more of the following criteria:

actionModeList

- **DISABLED:**
Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.
- **RECOMMENDED:**
Recommend the action so a user can execute it via the given hypervisor or by other external means
- **MANUAL:**
Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.
- **AUTOMATED:**
You have directed Turbonomic to execute the action automatically.
- **COLLECTION (UNUSED):**
Legacy action mode, no longer used.

actionStateList

- **DISABLED:**
An action whose policy has been disabled.
- **RECOMMEND:**
An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.
- **PENDING_ACCEPT:**
When the action mode is set to manual, a recommended action that has not been accepted or cleared.
- **ACCEPTED:**

An action that has been accepted, but is not yet in progress.

- **IN_PROGRESS:**

An action that is being executed.

- **SUCCEEDED:**

An action that was accepted and completed successfully.

- **FAILED:**

An action that was accepted and did not complete successfully.

- **REJECTED:**

When the action mode is set to manual, an action that has been rejected by the user.

- **CLEARED:**

When the action mode is set to manual, an action that is no longer recommended by the market.

- **ACCOUNTING:**

For cloud entities, an action to resize in order to use a different instance template.

- **QUEUED:**

When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

actionTypeList

- **START:**

Start an entity, and add it to the Turbonomic market.

- **MOVE:**

Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.

- **SUSPEND:**

Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.

- **ADD_PROVIDER:**

This is equivalent to the START action, but for storage entities.

- **CHANGE:**

Move a virtual machine's storage between datastores.

- **PROVISION:**

Add capacity to your environment.

- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR_EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR_PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

cleared

Default: `false`.

When `true`, actions that were removed from the action list before being executed will be returned.

costType

- **Saving**

An action that will decrease cloud spending.

- **Investment**

An action that will increase cloud spending.

cumulative

Default: `false`.

When `true`, shows the savings for each action in a scope as a cumulative total, rather than showing the savings for individual actions.

environmentType

- **ONPREM:**

Returns only actions related to entities that are part of your on-premises environment.

- **CLOUD:**

Returns only actions related to entities that are part of your cloud environment.

groupBy

You may group the actions returned by the following criteria: `[actionModes, actionStates, actionTypes, risk, riskSeverity, riskSubCategory]`

hasReservedInstance

Default: `false`.

When `true`, only actions that are related to reserved instances will be returned.

relatedEntityTypes

Returns only actions related to entities of these types within the scope. For example, if your scope is a virtual datacenter and you specify `VirtualMachine` as a related entity type, the request will include only those actions related to VMs in the specified virtual datacenter.

Choose from the following entity types: `[Datacenter, PhysicalMachine, VirtualMachine, Storage, Application, Chassis, DiskArray, IOModule, StorageControl, Switch, VirtualDataCenter, VPod, DPod, Container, Database, DatabaseServerContainer, LogicalPool]`

riskSeverityList

Returns only actions of the given severities: `[Unknown, Normal, Minor, Major, Critical]`

riskSubCategoryList

returns only actions of the given subcategories: [Performance Assurance, Efficiency Improvement, Prevention, Compliance]

Example: POST <https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/actions/stats>

Example input: Get a list of stats for actions that meet the following criteria, grouped by the actionMode of the action, in order of severity:

- Is in state PENDING_ACCEPT
- Is part of an on-premises environment
- Is an action for a virtual machine
- Is an action generated by the Turbonomic real-time market

```
{
  "actionInput": {
    "actionStateList": [
      "PENDING_ACCEPT"
    ],
    "environmentType": "ONPREM",
    "groupBy": [
      "actionModes"
    ]
  },
  "relatedType": "VirtualMachine"
}
```

Response: A list of StatSnapshotApiDTOs that aggregate statistics about the filtered actions.

```
[
  {
    "date": "2019-04-24T03:56:34-04:00",
    "statistics": [
      {
        "name": "numActions",
        "values": {
          "max": 1,
          "min": 1,
          "avg": 1,
          "total": 1
        },
        "value": 1
      },
      {
        "name": "costPrice",
        "filters": [
          {
            "type": "property",
            "value": "savings"
          }
        ],
        "units": "$",
        "values": {
          "max": 69.77539,
          "min": 69.77539,
          "avg": 69.77539,
          "total": 69.77539
        },
        "value": 69.77539
      },
      {
        "name": "numEntities",
        "values": {
          "max": 1,
          "min": 1,
          "avg": 1,
          "total": 1
        },
        "value": 1
      }
    ]
  }
]
```

]

Getting the Constraints for placement of an entity

When it calculates where to place an entity, Turbonomic respects whatever placement constraints there might be in your environment. For example, unless you have a Merge Cluster policy in effect, VM placement is constrained to hosts in the same cluster.

This call gets a ConstraintApiDTO object, which describes these constraints for the specified entity. The data in this object is equivalent to the Placement Constraints view that you can see in the user interface. To see this view, you drill down to the policy view for a single entity. In this view you can see the entity's related providers and consumers. You can also open a view for each related entity to show the constraints that limit potential placement for the entity. Also in this view, you can test out different placement options. (For information about testing different placement options, see [Inspecting placement options within constraints for an element](#).)

In the same way, the ConstraintApiDTO contains data objects to describe the current placement relationships, as well as potential changes you could make. The DTO delivers an array of objects for each consumer or provider. Within each object:

- `relation` indicates whether the entity is a provider (bought) or consumer (sold)
- `relatedEntities` describes the current consumer or provider
- `placementOptions` show other placement you could exploit for this relationship, if you were to remove the current constraints (via merge policies or other means)

Example: GET <https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/constraints>

Response: This listing shows a subset of the related entities and placement options:

```
[
  {
    "relation": "bought",
    "entityType": "PhysicalMachine",
    "relatedEntities": [
      {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/30333436-3638-5355-4532-313159335631?include_aspects=false"
          }
        ],
        "uuid": "30333436-3638-5355-4532-313159335631",
        "displayName": "hp-dl571.dev.mycorp.com",
        "className": "PhysicalMachine",
        "priceIndex": 6.577457,
        "state": "ACTIVE",
        "severity": "Normal",
        "discoveredBy": {
          "uuid": "_FJwg0EzHEemaXZFq01sC0g",
          "displayName": "vsphere-dc11.dev.mycorp.com",
          "type": "vCenter"
        },
        "remoteId": "host-30",
        "environmentType": "ONPREM"
      }
    ],
    "numPotentialEntities": 1,
    "placementOptions": [
      {
        "constraintType": "ClusterCommodity",
        "scope": {
          "uuid": "17fe23bc346750d62dce8ba4274fa99b4739975f",
          "displayName": "Cloud\\Physical"
        },
        "target": {
          "uuid": "_FJwg0EzHEemaXZFq01sC0g",
          "displayName": "vCenter:vsphere-dc11.dev.mycorp.com",
          "type": "vCenter"
        }
      },
      {
        "numPotentialEntities": 3,

```

```

    "key": "Cluster::17fe23bc346750d62dce8ba4274fa99b4739975f"
  },
  {
    "constraintType": "NetworkCommodity",
    "scope": {
      "displayName": "NetworkCommodity/vEOS-4"
    },
    "numPotentialEntities": 2,
    "key": "DistributedVirtualPortgroup:vmnet4"
  },
  {
    "constraintType": "DatastoreCommodity",
    "scope": {
      "uuid": "5a822e24-584bce98-ecb2-441ea15e2534",
      "displayName": "SCIO:ESXDC11DS2"
    },
    "target": {
      "uuid": "_FJwg0EzHEemaXZFq01sC0g",
      "displayName": "vCenter:vsphere-dc11.dev.mycorp.com",
      "type": "vCenter"
    },
    "numPotentialEntities": 2,
    "key": "Storage:5a822e24-584bce98-ecb2-441ea15e2534"
  },
  {
    "constraintType": "DataCenterCommodity",
    "scope": {
      "uuid": "98e12595449d993db8861c1f94c8f86ba277f17b",
      "displayName": "Cloud"
    },
    "target": {
      "uuid": "_FJwg0EzHEemaXZFq01sC0g",
      "displayName": "vCenter:vsphere-dc11.dev.mycorp.com",
      "type": "vCenter"
    },
    "numPotentialEntities": 7,
    "key": "DataCenter::98e12595449d993db8861c1f94c8f86ba277f17b"
  }
]
},
{
  "relation": "sold",
  "entityType": "Application",
  ...
}
]

```

Inspecting Placement Options Within Constraints for an Element

Within the given constraints that limit placement of an entity, there are usually a number of options for placement. The current placement is just one of many.

For information about getting entity constraints, see [Getting the Constraints for Placement of an Entity](#).

When you get the constraints for an entity, the `ConstraintApiDTO` includes other placement options for that entity on its providers, and options to place other consumers on the entity. The call in this section passes these placement options and returns the respective providers or consumers that satisfy the resulting constraint changes.

Making this call is equivalent to clicking **Find More Placement Options** in the user interface. To see this in the user interface, set the scope to a single entity, display the **POLICIES** tab, and scroll down to the Placement Constraints section. Then click **Constraints** next to the provider you want to explore, and click **Find More Placement Options**.

Example: POST <https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/constraints/entities>

Example input: In this example, we pass two placement options, that we copied from a `ConstraintApiDTO` for the entity we're inspecting. Note that each placement option in the `ConstraintApiDTO` includes a `constraintType` and a `key`. To pass a placement option, these

are the only fields we need. For this example we pass a `ClusterCommodity` constraint and a `DatastoreCommodity` constraint.

```
{
  "relation": "bought",
  "placementOptions": [
    {
      "constraintType": "ClusterCommodity",
      "key": "Cluster::17fe23bc346750d62dce8ba4274fa99b4739975f"
    },
    {
      "constraintType": "DatastoreCommodity",
      "key": "Storage::5a822e24-584bce98-ecb2-441ea15e2534"
    }
  ]
}
```

Response: In the data we posted (above), the cluster commodity has three potential entities, and the datastore commodity has two potential entities. The response brings back the intersection of these three potential provider entities – Two hosts.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/30343835-3638-584d-5131-323530394e39?include_aspects=false"
      }
    ],
    "uuid": "30343835-3638-584d-5131-323530394e39",
    "displayName": "hp-dl569.dev.mycorp.com",
    "className": "PhysicalMachine",
    "priceIndex": 1.031998,
    "state": "ACTIVE",
    "severity": "Normal",
    "discoveredBy": {
      "uuid": "_FJwg0EzHEemaXZFq01sC0g",
      "displayName": "vsphere-dc11.dev.mycorp.com",
      "type": "vCenter"
    },
    "remoteId": "host-3323",
    "environmentType": "ONPREM"
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/30333436-3638-5355-4532-313159335631?include_aspects=false"
      }
    ],
    "uuid": "30333436-3638-5355-4532-313159335631",
    "displayName": "hp-dl571.dev.mycorp.com",
    "className": "PhysicalMachine",
    "priceIndex": 6.916899,
    "state": "ACTIVE",
    "severity": "Normal",
    "discoveredBy": {
      "uuid": "_FJwg0EzHEemaXZFq01sC0g",
      "displayName": "vsphere-dc11.dev.mycorp.com",
      "type": "vCenter"
    },
    "remoteId": "host-30",
    "environmentType": "ONPREM"
  }
]
```

Getting Group Membership of an Entity

Referenced Endpoint: [Groups](#)

The Groups endpoint tells you which entities are in a given group. The `/entities/{entity_Uuid}/groups` call tells you which groups a given entity belongs to. You can make this call in two modes:

- Include relationship paths

In this mode the results include only those groups that are in a buy or sell relationship with the entity. For example, a VM entity might have relationships with a datacenter and a host cluster. The call would return entries for the datacenter, the host cluster, and the VM itself.

- Do not include relationship paths

In this mode the call returns every group that includes the passed entity as a member entity. This can be a large number of groups, including all the discovered groups as well as any custom groups you created. The results do not show buy/sell relationships.

This request takes the following parameters:

entity_Uuid

The UUID of the entity whose actions will be returned.

path

Default: false. When true, results include only related groups, and they show the providers and consumers for each group when applicable.

Examples:

- All groups (path = false): GET `https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/groups?path=false`
- Buy/Sell related groups, only (path = true): GET `https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/groups?path=true`

Response: A list of related groups. For the default (path = false), this returns an array of group objects.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/groups/_1Slr0GddEemDFcIzuV5wcQ?include_aspects=false"
      }
    ],
    "uuid": "_1Slr0GddEemDFcIzuV5wcQ",
    "displayName": "CUD_Vm_Group_vEOS",
    "className": "Group",
    "environmentType": "ONPREM",
    "entitiesCount": 5,
    "membersCount": 5,
    "groupType": "VirtualMachine",
    "severity": "Normal",
    "isStatic": true,
    "logicalOperator": "OR",
    "activeEntitiesCount": 3
  },
  ...
]
```

Getting Settings Policies Affecting an Entity

Referenced Endpoint: [Settings Policies](#)

This call returns an array of SettingsPolicyApiDTOs for all the Automation Policies that are effective for the given entity. Note that one entity can be in multiple groups, and so it can have policies that set different values for the same setting. In that case, the most conservative setting takes effect. The data returned by this call does not reflect which setting takes precedence in this case. The call merely reflects what you would see in the user interface.

Example: GET https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/settingspolicies

Response: An array of SettingsPolicyApiDTOs that are effective for the entity.

```
[
  {
    "uuid": "_i-QuUGXUEemoItN1K8jw3Q",
    "displayName": "CUD_VM_AUTOMATION_POLICY",
    "entityType": "VirtualMachine",
    "scopes": [
      {
        "uuid": "_BZbFswXUEemoItN1K8jw3Q",
        "displayName": "CUD_VM_Group",
        "groupType": "VirtualMachine",
        "isStatic": true,
        "logicalOperator": "AND"
      }
    ],
    "settingsManagers": [
      {
        "uuid": "automationmanager",
        "displayName": "Action Mode Settings",
        "category": "Automation",
        "settings": [
          {
            "uuid": "startVM",
            "displayName": "Start",
            "value": "MANUAL",
            "defaultValue": "RECOMMEND",
            "valueType": "STRING",
            "options": [
              {
                "label": "Disabled",
                "value": "DISABLED"
              },
              {
                "label": "Recommend",
                "value": "RECOMMEND"
              },
              {
                "label": "Manual",
                "value": "MANUAL"
              },
              {
                "label": "Automated",
                "value": "AUTOMATIC"
              }
            ],
            "entityType": "VirtualMachine",
            "sourceGroupName": "Global"
          }
        ]
      }
    ],
    "disabled": false,
    "readOnly": false,
    "default": false
  }
]
```

Getting Statistics of an Entity

Referenced Endpoint: [Stats](#)

Gets all statistics for the specified entity. This request takes the following parameters:

entity_uuid

The entity whose statistics will be returned.

q

Used internally by Turbonomic.

Example: GET https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/stats

Response: A list of StatSnapshotApiDTOs representing the current values of the statistics.

```
[
  {
    "displayName": "AdityaReplica",
    "date": "2019-04-24T20:09:46-04:00",
    "statistics": [
      {
        "name": "priceIndex",
        "relatedEntityType": "VirtualMachine",
        "values": {
          "max": 1.01,
          "min": 1.01,
          "avg": 1.01,
          "total": 1.01
        },
        "value": 1.01
      },
      {
        "displayName": "CPUProvisioned/AdityaReplica",
        "name": "CPUProvisioned",
        "capacity": {
          "max": 3120000,
          "min": 3120000,
          "avg": 3120000,
          "total": 3120000
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "bought"
          }
        ],
        "units": "MHz",
        "values": {
          "max": 5200,
          "min": 5200,
          "avg": 5200,
          "total": 5200
        },
        "value": 5200
      },
      {
        "displayName": "Swapping/AdityaReplica",
        "name": "Swapping",
        "capacity": {
          "max": 40000000,
          "min": 40000000,
          "avg": 40000000,
          "total": 40000000
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "bought"
          }
        ],
        "units": "bit/sec",
        "values": {
          "max": 0,
          "min": 0,
          "avg": 0,
          "total": 0
        },
        "value": 0
      },
      {
        "displayName": "NumDisk/AdityaReplica",
        "name": "NumDisk",
        "capacity": {
          "max": 2147483650,
          "min": 2147483650,
          "avg": 2147483650,
          "total": 2147483650
        }
      }
    ]
  }
]
```

```

    },
    "relatedEntityType": "VirtualMachine",
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "values": {
      "max": 1,
      "min": 1,
      "avg": 1,
      "total": 1
    },
    "value": 1
  },
  ...
]
}
]

```

Getting a Filtered List of Statistics for an Entity

Referenced Endpoint: [Stats](#)

Gets a list of statistics filtered by a user-created StatPeriodApiInputDTO. For more information about the criteria that make up the input for this request, see the Swagger documentation for this request, located at https://<Your_Turbonomic_IP>/swagger/external/index.html.

Example: POST <https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/stats>

Example Input: This input will return the values for the VMem, VCPU, and VStorage statistics of the specified entity, ordered first by key, then relatedEntity, then virtualDisk.

```

{
  "statistics": [
    {
      "name": "VMem",
      "groupBy": [
        "key",
        "relatedEntity",
        "virtualDisk"
      ]
    },
    {
      "name": "VCPU",
      "groupBy": [
        "key",
        "relatedEntity",
        "virtualDisk"
      ]
    },
    {
      "name": "VStorage",
      "groupBy": [
        "key",
        "relatedEntity",
        "virtualDisk"
      ]
    }
  ]
}

```

Response: An array of StatSnapshotApiDTOs representing the filtered statistics for the entity:

```

[
  {
    "displayName": "vEOS-4",
    "date": "2019-04-25T17:57:02-04:00",
    "statistics": [

```

```

{
  "displayName": "vEOS-4",
  "name": "VCPU",
  "capacity": {
    "max": 2663,
    "min": 2663,
    "avg": 2663,
    "total": 2663
  },
  "relatedEntityType": "VirtualMachine",
  "filters": [
    {
      "type": "virtualDisk",
      "value": ""
    },
    {
      "type": "key",
      "value": null
    },
    {
      "type": "relation",
      "value": "sold"
    }
  ],
  "relatedEntity": {
    "uuid": "c0849b50a2cce61f57ea0e49e2199503e82f3f54",
    "displayName": "GuestLoad[vEOS-4]",
    "className": "Application"
  },
  "units": "MHz",
  "values": {
    "max": 143,
    "min": 91.47,
    "avg": 91.47,
    "total": 91.47
  },
  "value": 91.47
},
{
  "displayName": "vEOS-4",
  "name": "VMem",
  "capacity": {
    "max": 2097152,
    "min": 2097152,
    "avg": 2097152,
    "total": 2097152
  },
  "relatedEntityType": "VirtualMachine",
  "filters": [
    {
      "type": "virtualDisk",
      "value": ""
    },
    {
      "type": "key",
      "value": null
    },
    {
      "type": "relation",
      "value": "sold"
    }
  ],
  "relatedEntity": {
    "uuid": "c0849b50a2cce61f57ea0e49e2199503e82f3f54",
    "displayName": "GuestLoad[vEOS-4]",
    "className": "Application"
  },
  "units": "KB",
  "values": {
    "max": 188740,
    "min": 130022,
    "avg": 130022,
    "total": 130022
  },
  "value": 130022
}
]
}
]

```

Getting the Supply Chain of an Entity

Referenced Endpoint: [Supply Chains](#)

Turbonomic models your environment as a market of buyers and sellers. It maps the entities it discovers to a supply chain that represents the buy/sell relationships between these entities.

In the user interface, the default view on the Home Page shows the global supply chain. You can change scope to drill down to a supply chain for the relationships to a single entity. This is the same as the result when you get a supply chain for an entity via the API. The returned data is a SupplyChainApiDTO that expresses the scope for the passed entity.

The supply chain shows tiers of entity types, where depth indicates where in the supply chain levels a specific tier is. When you get a supply chain for an entity, the entity is at `depth = 0`. The depths for tiers above the entity are negative. For example, if a VM is at `depth = 0`, then the application that consumes from the VM would be at `depth = -1`. Likewise, providers to the VM would have positive depths. For example, storage that provides resources to the VM would have `depth = 1`, and a disk array that hosts the storage would have `depth = 2`.

The supply chain request takes the following parameters:

entity_uuid

The entity that sets the scope of the supply chain.

types

An array of strings for the entity types you want to include in the supply chain. If you leave this blank, the call returns the complete supply chain for this entity. If you specify any types, the returned supply chain contains only those types. Note that this rule also applies to the entity that sets the scope (`entity_uuid`) – If you do not include that entity's type, then the supply chain will not include that entity, even though it sets the scope of the request.

entity_states

An array of strings. Limit the supply chain to include only entities in the given state. Entity states are:

- **ACTIVE:** The entity is actively consuming resources
- **EVACUATED:** All consumers have been moved off of the entity, and it can be suspended or terminated
- **FAILOVER:** The entity is reserved for failover and will not participate in the market
- **IDLE:** The entity is powered off and not actively consuming market resources
- **LAUNCH:** The entity is starting up
- **MAINTENANCE:** The entity is in Maintenance mode
- **NOT_MONITORED:** Turbonomic does not currently monitor the entity
- **QUEUED:** More than ten actions are to be executed for a single target, and this entity has pending actions in the queue
- **RESOURCE_ALLOCATION:** For internal use
- **RESOURCE_RELEASE:** For internal use
- **SUSPEND:** The entity has been placed in Suspend mode
- **SUSPEND_PENDING:** The entity is making preparations to suspend, or is the next entity of its type to suspend
- **TERMINATE_PENDING:** The entity is making preparations to terminate, or is the next entity of its type to terminate
- **UNKNOWN:** Turbonomic is unable to obtain the current state of the entity

environment_type

Limit the supply chain to a specific environment type. If you do not specify environment type, the supply chain includes all environments, which is the same as **HYBRID**. The environment types are:

- **HYBRID**

- CLOUD
- ONPREM

detail_type

The level of detail you want in your supply chain. Can be one of:

- compact: Minimal detail about the supply chain items
- entity: The supply chain items include full entity descriptions
- aspects: The supply chain items also include aspects (meta data stored with the entity)

health

Whether to include a health summary with the entities in the supply chain. false by default.

Example: GET https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073/supplychains?types=VirtualMachine&types=Storage&types=DiskArray&detail_type=compact&health=true

This example gets a supply chain for a VM entity, with the following settings: including the VM, storage, and disk arrays:

- Only include the VM, its storage, and the disk arrays
- Give compact details
- Show the entity health

Response: The SupplyChainApiDTO for the filtered request:

```
{
  "seMap": {
    "VirtualMachine": {
      "depth": 0,
      "entitiesCount": 1,
      "healthSummary": {
        "Normal": 1
      },
      "stateSummary": {
        "ACTIVE": 1
      },
      "ConnectedProviderTypes": [
        "PhysicalMachine",
        "Storage",
        "VirtualDataCenter"
      ],
      "ConnectedConsumerTypes": [
        "Application"
      ],
      "instances": {
        "420b1eeb-6190-a9d2-6436-4327ad3ac073": {
          "links": [
            {
              "rel": "self",
              "href": "https://10.10.10.10/api/v3/entities/420b1eeb-6190-a9d2-6436-4327ad3ac073?include_aspects=false"
            }
          ],
          "uuid": "420b1eeb-6190-a9d2-6436-4327ad3ac073",
          "displayName": "vEOS-4",
          "className": "VirtualMachine",
          "priceIndex": 1.1463195,
          "state": "ACTIVE",
          "severity": "Normal",
          "discoveredBy": {
            "uuid": "_FJwg0EzHEmaXZFq01sC0g",
            "displayName": "vsphere-dc11.dev.mycorp.com",
            "type": "vCenter"
          },
          "remoteId": "vm-100",
          "environmentType": "ONPREM"
        }
      },
      "Storage": {
        "depth": 1,
```

```

    "entitiesCount": 2,
    "healthSummary": {
      "Normal": 2
    },
    "stateSummary": {
      "ACTIVE": 2
    },
    "connectedProviderTypes": [
      "DiskArray"
    ],
    "connectedConsumerTypes": [
      "PhysicalMachine",
      "VirtualMachine"
    ],
    "instances": {
      "5a822e24-584bce98-ecb2-441ea15e2534": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/5a822e24-584bce98-ecb2-441ea15e2534?include_aspects=false"
          }
        ],
        "uuid": "5a822e24-584bce98-ecb2-441ea15e2534",
        "displayName": "SCIO:ESXDC11DS2",
        "className": "Storage",
        "priceIndex": 1.2797012,
        "state": "ACTIVE",
        "severity": "Normal",
        "discoveredBy": {
          "uuid": "_FJwg0EzHEemaXZFq01sC0g",
          "displayName": "vsphere-dc11.dev.mycorp.com",
          "type": "vCenter"
        },
        "remoteId": "datastore-2357",
        "environmentType": "ONPREM",
        "tags": {
          "Datastore_DC11": [
            "True"
          ]
        }
      },
      "9bd4ee88-99c64661": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/9bd4ee88-99c64661?include_aspects=false"
          }
        ],
        "uuid": "9bd4ee88-99c64661",
        "displayName": "QS1:NFSShare",
        "className": "Storage",
        "priceIndex": 20000,
        "state": "ACTIVE",
        "severity": "Normal",
        "discoveredBy": {
          "uuid": "_g0QEYEaREemB8r4uTzazvA",
          "displayName": "vsphere-dc5.dev.mycorp.com",
          "type": "vCenter"
        },
        "remoteId": "datastore-1411",
        "environmentType": "ONPREM",
        "tags": {
          "DimStor": [
            "DimStorTag"
          ],
          "Datastore_DC11": [
            "True"
          ],
          "Test_Tag": [
            "MyStorageTag"
          ]
        }
      }
    },
    "DiskArray": {
      "depth": 2,
      "entitiesCount": 2,
      "healthSummary": {
        "Normal": 2
      }
    }
  }
}

```

```

    },
    "stateSummary": {
      "ACTIVE": 2
    },
    "connectedConsumerTypes": [
      "Storage"
    ],
    "instances": {
      "DiskArray-9bd4ee88-99c64661": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/DiskArray-9bd4ee88-99c64661?include_aspects=false"
          }
        ],
        "uuid": "DiskArray-9bd4ee88-99c64661",
        "displayName": "DiskArray-QS1:NFSShare",
        "className": "DiskArray",
        "priceIndex": 0,
        "state": "ACTIVE",
        "severity": "Normal",
        "discoveredBy": {
          "uuid": "_oQ2aIEG1EemgjaEqcE-BJw",
          "displayName": "vsphere-dc13.dev.mycorp.com",
          "type": "vCenter"
        },
        "remoteId": "datastore-982",
        "environmentType": "ONPREM"
      },
      "DiskArray-5a822e24-584bce98-ecb2-441ea15e2534": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/DiskArray-5a822e24-584bce98-ecb2-441ea15e2534?include_aspects=false"
          }
        ],
        "uuid": "DiskArray-5a822e24-584bce98-ecb2-441ea15e2534",
        "displayName": "DiskArray-SCIO:ESXDC11DS2",
        "className": "DiskArray",
        "priceIndex": 0,
        "state": "ACTIVE",
        "severity": "Normal",
        "discoveredBy": {
          "uuid": "_FJwg0EzHEemaXZFq01sC0g",
          "displayName": "vsphere-dc11.dev.mycorp.com",
          "type": "vCenter"
        },
        "remoteId": "datastore-2357",
        "environmentType": "ONPREM"
      }
    }
  }
}
}
}
}
}

```

Getting the Tags on an Entity

Referenced Endpoint: [Tags](#)

Turbonomic discovers tags and tag values that are assigned to different entities in your environment. This call returns the tag and value sets for the entity you pass.

Example: GET <https://10.10.10.10/api/v3/entities/9bd4ee88-99c64661/tags>

Response: A TagApiDTO for the passed entity. This gives an array of key/value pairs, where the value is an array of strings.

```

[
  {
    "key": "Datastore_DC11",
    "values": [
      "True"
    ]
  },

```



```

{
  "key": "Test_Tag",
  "values": [
    "MyStorageTag"
  ]
},
{
  "key": "DimStor",
  "values": [
    "DimStorTag"
  ]
}
]

```

Groups Endpoint

A group is a collection of entities (such as physical machines, containers, clusters, or even other groups) that Turbonomic can work with as a unit. The most common use of groups is to set scope for display in charts or for processing in plans, and to retrieve statistics for a subset of your environment.

This endpoint contains references to start and end times for certain operations. For more information, including valid time formats, see [Time in the Turbonomic API](#)

Using the groups endpoint of the Turbonomic API, you can:

- Get a list of all groups on your Turbonomic appliance
- Create a group
- Edit a group
- Delete a group
- Get a list of actions for a specified groups
- Get a list of entities in a specified group
- Get parent groups of a specified group
- Get a list of members of a specified group
- Get a list of notifications for a specified group
- Get a list of settings for a specified group
- Get a list of policies for a specified group
- Get statistics for a specified group
- Get the supply chain related to a specified group
- Get the tags belonging to a specified group

Group Types and Class Names

Turbonomic subdivides the entities on your appliance by the following group class name, to aid in both searching and understanding the purpose of a group:

Folder

These appear in the user interface as folders, and are for visual organization. Discovered folders represent the folder structure in the target — for example, the vCenter folder structure. In addition, Turbonomic discovers vCenter Server resource pools, and groups them into folders.

Group

Turbonomic places discovered entities into standard groups, and users can create groups of their own with static or dynamic membership.

RefGroup

A RefGroup can be a group of groups- for example, a group of PM cluster groups that make up a hypervisor target- or a group defined by a relationship. For example, the built-in group PMsByDatacenter is a RefGroup reflecting the relationship between the datacenters and hosts.

Cluster / StorageCluster

Groups that correspond to discovered clusters.

DiscoveredGroup

Groups that are defined by a target service. For example, Turbonomic can discover DRS domains that were defined in vCenter Server.

MarketGroup

A group that is based on the infrastructure cost of that entity type. These groups are based on the Infrastructure Cost settings in the Turbonomic policies.

StaticMetaGroup / RefMetaGroup / MetaGroup

Groups used internally by Turbonomic. These should not be modified in any way.

In addition, each group has a `groupType` that identifies the type of members that group contains. Remember that when you create a group in the user interface or via the API, you cannot add more than one type of member. The different group types include:

Cluster

A group of clusters. For example, you could create a group of all PM clusters that include the name "Development".

ServiceEntity

An internal group type reserved for groups that Turbonomic discovers or creates. Note that the group will still contain members of only one type.

Entity Type

- BUSINESS_UNIT
- CLOUD_SERVICE
- CONTAINER
- DATABASE
- DATABASE_SERVER
- DATACENTER
- DISK_ARRAY
- PHYSICAL_MACHINE
- STORAGE
- VIRTUAL_MACHINE
- SWITCH
- VIRTUAL_DATACENTER
- CHASSIS
- STORAGE_CONTROLLER
- IO_MODULE
- APPLICATION_SERVER
- VIRTUAL_APPLICATION
- NETWORK
- APPLICATION
- CONTAINER
- CONTAINER_POD
- LOGICAL_POOL
- DPOD
- VPOD
- LOAD_BALANCER

Understanding the different group types helps you find the group you want. If you know the name of a specific group, then you can filter the returned list for a group of that name. Or if you want to step through all the clusters Turbonomic has discovered, you can filter all the entries with a `className` of `Cluster` or `StorageCluster`.

Group Filter Types

Turbonomic utilizes regex and a `filterType` to build a group. The `filterType` is the criterion to which the regex will match. For example, a `filterType` of `pmsByName` will apply the regex to the display names of physical machines.

The available options for this parameter depend on the entity making up your group:

VirtualMachine

- `vmsByName`
- `vmsByPMName`
- `vmsByStorage`
- `vmsByNetwork`
- `vmsByApplication`
- `vmsByDatabaseServer`
- `vmsByDatabaseServerVersion`
- `vmsByDC`
- `vmsByVDC`
- `vmsByDCnested`
- `vmsByNumCPUs`
- `vmsByMem`
- `vmsByGuestName`
- `vmsByAltName`
- `vmsByClusterName`
- `vmsByDiskArrayName`
- `vmsByLogicalPoolName`
- `vmsByTag`
- `vmsByState`
- `vmsByBusinessAccountUuid`
- `vmsByResourceGroupUuid`

VirtualDataCenter

- `vdcsByName`
- `vdcsByVDCName`
- `vdcsByTag`
- `vdcsByState`

PhysicalMachine

- `pmsByName`
- `pmsByStorage`
- `pmsByNetwork`
- `pmsBySwitch`
- `pmsByNumVms`
- `pmsByDC`

- pmsByMem
- pmsByNumCPUs
- pmsByVendorName
- pmsByCPUModel
- pmsByModel
- pmsByTimezone
- pmsByClusterName
- pmsByTag
- pmsByState

Storage

- storageByName
- storageByTag
- storageByVMs
- storageByDC
- storageByPMCluster
- storageByState
- volumeByDeletable

Application Component

- appSrvsByName
- appsByName

WebServer

- wbSrvsByName

BusinessApplication

- busAppsByName

Database

- databaseByName
- databaseByTag
- databaseByBusinessAccountUuid
- databaseByResourceGroupUuid

DatabaseServer

- databaseServerByName
- databaseServerByTag
- databaseServerByBusinessAccountUuid
- databaseServerByEngine
- databaseServerByEdition
- databaseServerByVersion

VirtualApplication

- vappsByName

Cluster

- clustersByName
- clustersByTag

DataCenter

- datacentersByName
- datacentersByTag

Group

- groupsByName

StorageCluster

- storageClustersByName

DiskArray

- diskarrayByName

Zone

- zonsByName

Region

- regsByName

Network

- netsByName

LoadBalancer

- lbsByName

Chassis

- chasByName

StorageController

- storagecontrollerByName

DPod

- dpodByName

VPod

- vpodByName

LogicalPool

- logicalPoolByName

Switch

- switchByName

Container

- containersByName
- containersByPodName
- containersByVMName
- containersByNamespace
- containerSpecsByName

ContainerPod

- containerPodsByName
- containerPodsByNamespace
- containerPodsByVMName

ServiceEntity

Note: Groups of type ServiceEntity are the only groups that have multiple entity types, and are used exclusively for cloud targets.

- workloadByBusinessAccountUuid
- workloadByResourceGroupUuid

Workload

- workloadByBusinessAccountUuid
- workloadByResourceGroupUuid
- workloadControllersByName
- workloadControllersByNamespace
- workloadControllersByKind
- ResourceGroup
- resourceGroupByName
- resourceGroupByUuid
- resourceGroupByBusinessAccountUuid

BusinessAccount

- businessAccountByName
- businessAccountByUuid
- subBusinessAccountOfUuid
- businessAccountValidationStatus
- businessAccountTargetName
- businessAccountCloudProvider

BillingFamily

- billingFamilyByName

ViewPod

- viewPodByName

DesktopPool

- desktopPoolByName
- desktopPoolByViewPod

BusinessUser

- businessUserByDesktopPool
- businessUserByName
- businessUserByViewPod

Cloud-Specific Filters

- computeTiersByName
- computeTiersByMem
- databaseTiersByName
- databaseTiersByDBMem
- databaseServerTiersByName
- databaseServerTiersByVMem

Note that in the case of a discovered resource group, group members can be discovered by multiple targets. In that case, the Turbonomic API returns a single target for the group.

Groups Requests

Pagination for Group Requests

When you request group data, the API uses pagination to return subsets of the data. You should always use pagination when available to make sure you get your data in manageable chunks. To paginate returned data, the `limit`, `orderBy`, and `cursor` parameters control how the APIs paginate their data. If you do not specify a `limit` for the following requests, the API will paginate the data to a default limit of records:

- GET `/groups`
- GET `/groups/<groupId>/members`
- GET `/groups/<groupId>/entities`

If your scripts make these requests without setting a limit, you should be sure they check for a pagination cursor in the returned data.

For general information about pagination, see [Pagination in the Turbonomic API](#).

Getting a List of Groups

Gets a list of all groups on your Turbonomic appliance. This will include Turbonomic internal and default groups, as well as any groups discovered from your targets, in addition to your custom groups.

Example: GET `https://10.10.10.10/api/v3/groups`

Response: A list of `GroupApiDTO`s representing the groups on your appliance.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/groups/_S4k98SFQEd-S4dn3K4_SSA?include_aspects=false"
      }
    ],
    "uuid": "_S4k98SFQEd-S4dn3K4_SSA",
    "displayName": "Datacenters",
    "className": "Group",
    "environmentType": "ONPREM",
    "entitiesCount": 12,
    "membersCount": 12,
    "groupType": "DataCenter",
    "severity": "Critical",
    "isStatic": false,
    "logicalOperator": "AND",
    "activeEntitiesCount": 44
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/groups/_S4k94SFQEd-S4dn3K4_SSA?include_aspects=false"
      }
    ],
    "uuid": "_S4k94SFQEd-S4dn3K4_SSA",
    "displayName": "Chassis",
    "className": "Group",
    "environmentType": "ONPREM",
    "entitiesCount": 2,
    "membersCount": 1,
    "groupType": "Chassis",
    "severity": "Normal",
    "isStatic": false,
    "logicalOperator": "AND",
    "activeEntitiesCount": 2
  },
  ...
]
```

```
]
```

Creating a Group

In order to create a group in Turbonomic, provide a GroupApiDTO with a `groupType` and `isStatic`.

For a dynamic group (`isStatic = false`), you also include the `criteriaList` information:

caseSensitive

If `true`, the regex will be evaluated as case-sensitive.

expType

For strings, the allowable values are `EQ` and `NEQ` (Equals, Does Not Equal). For integers, you may additionally use `GT`, `LT`, `GTE`, `LTE` (Greater than, less than, greater than or equal to, and less than or equal to, respectively).

expVal

The value of the regular expression.

filterType

See **Group Filter Types** for a full list of available options

For a static group:

- Provide UUIDs for each entity that is a member of the group in the `memberUuidList`
- DO NOT provide any `criteriaList` parameters

Example: POST `https://10.10.10.10/api/v3/groups/`

Example input, showing the creation of a dynamic group of VMs whose names start with "AJ":

```
{
  "isStatic": false,
  "displayName": "Dallas-Dynamic",
  "memberUuidList": [],
  "criteriaList": [
    {
      "expType": "EQ",
      "expVal": "AJ.*",
      "filterType": "vmsByName",
      "caseSensitive": false
    }
  ],
  "groupType": "VirtualMachine"
}
```

Response:

```
{
  "uuid": "_4L0PcE9SEemD69d9a0uLJQ",
  "displayName": "Dallas-Dynamic",
  "className": "Group",
  "environmentType": "ONPREM",
  "entitiesCount": 1,
  "membersCount": 1,
  "groupType": "VirtualMachine",
  "severity": "Major",
  "isStatic": false,
  "logicalOperator": "AND",
  "criteriaList": [
    {
      "expVal": "AJ.*",
      "expType": "EQ",
      "filterType": "vmsByName",
      "caseSensitive": false
    }
  ],
  "activeEntitiesCount": 1
}
```


Example input, showing the creation of a static group of Hosts:

```
{
  "isStatic": true,
  "displayName": "Dallas-Static",
  "memberUuidList": [
    "4C4C4544-0042-5A10-804A-B1C04F384331",
    "4C4C4544-004A-3610-8057-C8C04F464331",
    "Virtual_ESX_42381e13-4256-64bb-f554-d17798ddb2ba"
  ],
  "criteriaList": [],
  "groupType": "PhysicalMachine"
}
```

Response:

```
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/groups/_vn_u0FJ0EemD69d9a0uLJQ?include_aspects=false"
    }
  ],
  "uuid": "_vn_u0FJ0EemD69d9a0uLJQ",
  "displayName": "Dallas-Static",
  "className": "Group",
  "environmentType": "ONPREM",
  "entitiesCount": 3,
  "membersCount": 3,
  "groupType": "PhysicalMachine",
  "severity": "Critical",
  "isStatic": true,
  "logicalOperator": "OR",
  "activeEntitiesCount": 3
}
```

Editing a Group

In order to edit a user-created group, send the complete GroupApiDTO with your changes as the input to this request.

Example: PUT https://10.10.10.10/api/v3/groups/_Y6BL4FDQEemD69d9a0uLJQ

Example Input: A modified GroupApiDTO. In this case, the expVal parameter has been modified.

```
{
  "isStatic": false,
  "displayName": "Dallas-Host",
  "memberUuidList": [],
  "criteriaList": [
    {
      "expType": "EQ",
      "expVal": "hp*change",
      "filterType": "pmsByName",
      "caseSensitive": false
    }
  ],
  "groupType": "PhysicalMachine",
  "logicalOperator": "AND"
}
```

Response: The full GroupApiDTO reflecting your changes:

```
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/groups/_Y6BL4FDQEemD69d9a0uLJQ?include_aspects=false"
    }
  ],
  "uuid": "_Y6BL4FDQEemD69d9a0uLJQ",
  "displayName": "Dallas-Host",

```

```

    "className": "Group",
    "environmentType": "ONPREM",
    "entitiesCount": 0,
    "membersCount": 0,
    "groupType": "PhysicalMachine",
    "severity": "Normal",
    "isStatic": false,
    "logicalOperator": "AND",
    "criteriaList": [
      {
        "expVal": "hp*change",
        "expType": "EQ",
        "filterType": "pmsByName",
        "caseSensitive": false
      }
    ],
    "activeEntitiesCount": 0
  }
}

```

Deleting a Group

To delete a user-created group, pass the UUID of the group in the URL of the request.

Example: DELETE https://10.10.10.10/api/v3/groups/_vn_u0FJ0EemD69d9a0uLJQ

Response: A response of 200 indicates successful deletion.

Getting Actions Related to a Group

Referenced Endpoint: [Actions](#)

Gets a list of actions relating to the entities in the specified group. To get a single action, include the UUID of the action in the request. This request takes the following parameters:

group_Uuid

The UUID of the group whose actions will be returned.

cursor

When making subsequent calls to retrieve additional results, this is the cursor returned by the last call to this method.

limit

The maximum number of items to return. Must be a positive integer. If not set, the server will provide a default (20).

order_by

The field to order the results by. [creation_date, name, risk_category, savings, severity].

ascending

Default: true. When false, results will be in descending order.

Examples:

All actions: GET

https://10.10.10.10/api/v3/groups/421dd4ce-a4c1-231a-71e7-64fbf598bc65/actions?limit=50&order_by=creation_date&ascending=true

Single action: GET https://10.10.10.10/api/v3/groups/421dd4ce-a4c1-231a-71e7-64fbf598bc65/actions/_pJg98EQaEemD69d9a0uLJQ

Response: A list of ActionApiDTOs related to the specified group:

```

[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/actions/_pJg98EQaEemD69d9a0uLJQ"
      },
      {

```

```

        "rel": "self",
        "href": "https://10.10.10.10/api/v3/actions/2500817580000"
    },
    {
        "uuid": "_pJg98EQaEemD69d9a0uLJQ",
        "createTime": "2019-03-11T12:28:03-04:00",
        "actionType": "RIGHT_SIZE",
        "actionState": "PENDING_ACCEPT",
        "actionMode": "MANUAL",
        "details": "Scale down Memory reservation for Virtual Machine 'AJ_Test' from 2 GB to 1 GB",
        "importance": 0,
        "target": {
            "uuid": "421dd4ce-a4c1-231a-71e7-64fbf598bc65",
            "displayName": "AJ_Test",
            "className": "VirtualMachine",
            "aspects": {
                "virtualMachineAspect": {
                    "os": "CentOS 4/5/6/7 (64-bit)",
                    "ip": [
                        "10.10.10.107"
                    ],
                    "connectedNetworks": [
                        {
                            "uuid": "34f9f5364cd843aa1fe99900621ee3b51a7dc6e5",
                            "displayName": "VM Network"
                        }
                    ],
                    "numVCPUs": 1,
                    "ebsOptimized": false
                }
            },
            "environmentType": "ONPREM"
        },
        "currentEntity": {
            "uuid": "_pJlPYUQaEemD69d9a0uLJQ",
            "className": "Mem"
        },
        "newEntity": {
            "uuid": "_pLCA40QaEemD69d9a0uLJQ",
            "className": "Mem",
            "aspects": {
                "virtualMachineAspect": {
                    "os": "Linux (Free)",
                    "ebsOptimized": false
                }
            }
        },
        "currentValue": "2097152.0",
        "newValue": "1048576.0",
        "resizeToValue": "1048576.0",
        "risk": {
            "uuid": "_pL_qMEQaEemD69d9a0uLJQ",
            "subCategory": "Efficiency Improvement",
            "description": "Underutilized Memory reservation",
            "severity": "MINOR",
            "importance": 0
        },
        "currentLocation": {
            "uuid": "cdcd967d1e08d20936c3aa9a0879c635214c79ee",
            "displayName": "ACM",
            "className": "DataCenter"
        },
        "newLocation": {
            "uuid": "cdcd967d1e08d20936c3aa9a0879c635214c79ee",
            "displayName": "ACM",
            "className": "DataCenter"
        },
        "actionID": 2500817580000
    },
    {
        "links": [
            {
                "rel": "self",
                "href": "https://10.10.10.10/api/v3/actions/_XdP4EEQ8EemD69d9a0uLJQ"
            },
            {
                "rel": "self",
                "href": "https://10.10.10.10/api/v3/actions/2501049335840"
            }
        ],
        "uuid": "_XdP4EEQ8EemD69d9a0uLJQ",
        "createTime": "2019-03-11T16:29:28-04:00",

```

```

"actionType": "RIGHT_SIZE",
"actionState": "PENDING_ACCEPT",
"actionMode": "MANUAL",
"details": "Remove VMem limit for VirtualMachine AJ_Test to maximize efficiency",
"importance": 0,
"target": {
  "uuid": "421dd4ce-a4c1-231a-71e7-64fbf598bc65",
  "displayName": "AJ_Test",
  "className": "VirtualMachine",
  "aspects": {
    "virtualMachineAspect": {
      "os": "CentOS 4/5/6/7 (64-bit)",
      "ip": [
        "10.10.10.107"
      ],
      "connectedNetworks": [
        {
          "uuid": "34f9f5364cd843aa1fe99900621ee3b51a7dc6e5",
          "displayName": "VM Network"
        }
      ],
      "numVCPUs": 1,
      "ebsOptimized": false
    }
  },
  "environmentType": "ONPREM"
},
"currentEntity": {
  "uuid": "_XdP4EkQ8EemD69d9a0uLJQ",
  "className": "VMem"
},
"newEntity": {
  "uuid": "_Xnq_YUQ8EemD69d9a0uLJQ",
  "className": "VMem",
  "aspects": {
    "virtualMachineAspect": {
      "os": "Linux (Free)",
      "ebsOptimized": false
    }
  }
},
"currentValue": "2097152.0",
"newValue": "0.0",
"resizeToValue": "0.0",
"risk": {
  "uuid": "_XnuCsUQ8EemD69d9a0uLJQ",
  "subCategory": "Efficiency Improvement",
  "description": "VMem congestion in Virtual Machine 'AJ_Test'",
  "severity": "MAJOR",
  "reasonCommodity": "VMem",
  "importance": 0
},
"currentLocation": {
  "uuid": "cdcd967d1e08d20936c3aa9a0879c635214c79ee",
  "displayName": "ACM",
  "className": "DataCenter"
},
"newLocation": {
  "uuid": "cdcd967d1e08d20936c3aa9a0879c635214c79ee",
  "displayName": "ACM",
  "className": "DataCenter"
},
"actionID": 2501049335840
}
]

```

Getting the Entities in a Group

Referenced Endpoint: [Entities](#)

Gets all entities contained within a group.

Note: This request will not return the contents of nested groups. In order to see groups of groups, use the groups/members request.

Example: GET https://10.10.10.10/api/v3/groups/_4L0PcE9SEemD69d9a0uLJQ/entities

Response: A list of EntityApiDTOs representing the entities in the specified group.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/actions/_pJg98EQaEemD69d9a0uLJQ"
      },
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/actions/2500817580000"
      }
    ],
    "uuid": "_pJg98EQaEemD69d9a0uLJQ",
    "createTime": "2019-03-11T12:28:03-04:00",
    "actionType": "RIGHT_SIZE",
    "actionState": "PENDING_ACCEPT",
    "actionMode": "MANUAL",
    "details": "Scale down Memory reservation for Virtual Machine 'AJ_Test' from 2 GB to 1 GB",
    "importance": 0,
    "target": {
      "uuid": "421dd4ce-a4c1-231a-71e7-64fbf598bc65",
      "displayName": "AJ_Test",
      "className": "VirtualMachine",
      "aspects": {
        "virtualMachineAspect": {
          "os": "CentOS 4/5/6/7 (64-bit)",
          "ip": [
            "10.10.10.107"
          ],
          "connectedNetworks": [
            {
              "uuid": "34f9f5364cd843aa1fe99900621ee3b51a7dc6e5",
              "displayName": "VM Network"
            }
          ],
          "numVCPUs": 1,
          "ebsOptimized": false
        }
      },
      "environmentType": "ONPREM"
    },
    "currentEntity": {
      "uuid": "_pJlPYUQaEemD69d9a0uLJQ",
      "className": "Mem"
    },
    "newEntity": {
      "uuid": "_pLCA40QaEemD69d9a0uLJQ",
      "className": "Mem",
      "aspects": {
        "virtualMachineAspect": {
          "os": "Linux (Free)",
          "ebsOptimized": false
        }
      }
    },
    "currentValue": "2097152.0",
    "newValue": "1048576.0",
    "resizeToValue": "1048576.0",
    "risk": {
      "uuid": "_pL_qMEQaEemD69d9a0uLJQ",
      "subCategory": "Efficiency Improvement",
      "description": "Underutilized Memory reservation",
      "severity": "MINOR",
      "importance": 0
    },
    "currentLocation": {
      "uuid": "cdcd967d1e08d20936c3aa9a0879c635214c79ee",
      "displayName": "ACM",
      "className": "DataCenter"
    },
    "newLocation": {
      "uuid": "cdcd967d1e08d20936c3aa9a0879c635214c79ee",
      "displayName": "ACM",
      "className": "DataCenter"
    },
    "actionID": 2500817580000
  }
]
```

]

Getting the Parent Groups of a Group

For a specified group, gets any group that the specified group belongs to.

Note: Turbonomic contains a default parent group for user-created groups called "My Groups". This group should not be modified or deleted.

This request takes the following parameters:

group_Uuid

The UUID of the group whose actions will be returned.

path

Default: `false`. When `true`, this request returns the parent group, along with any groups traversed to obtain the parent group. For groups that are not nested, this returns the group whose ID you entered and its parent group.

Example: GET https://10.10.10.10/api/v3/groups/_4L0PcE9SEemD69d9a0uLJQ/groups?path=true

Response: A list of GroupApiDTOs representing the group and parent group.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/groups/_S4k68yFvEd-S4dn3T4_SSA?include_aspects=false"
      }
    ],
    "uuid": "_S4k68yFvEd-S4dn3T4_SSA",
    "displayName": "My Groups",
    "className": "Group",
    "environmentType": "ONPREM",
    "entitiesCount": 1,
    "membersCount": 3,
    "groupType": "ServiceEntity",
    "severity": "Major",
    "isStatic": false,
    "logicalOperator": "AND",
    "activeEntitiesCount": 1
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/groups/_4L0PcE9SEemD69d9a0uLJQ?include_aspects=false"
      }
    ],
    "uuid": "_4L0PcE9SEemD69d9a0uLJQ",
    "displayName": "Dallas-Dynamic",
    "className": "Group",
    "environmentType": "ONPREM",
    "entitiesCount": 1,
    "membersCount": 1,
    "groupType": "VirtualMachine",
    "severity": "Major",
    "isStatic": false,
    "logicalOperator": "AND",
    "criterialList": [
      {
        "expVal": "AJ.*",
        "expType": "EQ",
        "filterType": "vmsByName",
        "caseSensitive": false
      }
    ],
    "activeEntitiesCount": 1
  }
]
```

]

Getting the Members of a Group

Referenced Endpoint: [Entities](#)

Gets all members of a group.

Note: This request returns nested groups and the member entities of each. To get only the *entities* in the specified group, use the `groups/entities` request.

Example: GET https://10.10.10.10/api/v3/groups/_4L0PcE9SEemD69d9a0uLJQ/members

Response: A list of `serviceEntityApiDTOs` representing the members of the group:

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/183b37c68211668aecd36eadcdce9110ebc58f85?include_aspects=false"
      }
    ],
    "uuid": "183b37c68211668aecd36eadcdce9110ebc58f85",
    "displayName": "Olga",
    "className": "VirtualDataCenter",
    "priceIndex": 1,
    "state": "ACTIVE",
    "severity": "Normal",
    "discoveredBy": {
      "uuid": "_h3Km4Bs3EemMFrqlXNi1yQ",
      "displayName": "vsphere-dc23.corp.vmturbo.com",
      "type": "vCenter"
    },
    "remoteId": "resgroup-96",
    "environmentType": "ONPREM"
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/2332ba0f9dc14c07f11adb38e12df43c4bc8ca56?include_aspects=false"
      }
    ],
    "uuid": "2332ba0f9dc14c07f11adb38e12df43c4bc8ca56",
    "displayName": "olga_do_not_touch_1",
    "className": "VirtualDataCenter",
    "priceIndex": 1,
    "state": "ACTIVE",
    "severity": "Normal",
    "discoveredBy": {
      "uuid": "_5kMqwNlnEeiJs9KWCz0dUQ",
      "displayName": "vsphere-dc1.dev.mycorp.com",
      "type": "vCenter"
    },
    "remoteId": "resgroup-1088",
    "environmentType": "ONPREM"
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/6668eb0940bf970d24eb13279b31a52f3c44a91f?include_aspects=false"
      }
    ],
    "uuid": "6668eb0940bf970d24eb13279b31a52f3c44a91f",
    "displayName": "Gilad",
    "className": "VirtualDataCenter",
    "priceIndex": 1,
    "state": "ACTIVE",
    "severity": "Normal",
    "discoveredBy": {
      "uuid": "_lj_tkH39EeiKy53b3GBglA",
      "displayName": "vsphere-dc5.dev.mycorp.com",
      "type": "vCenter"
    },
    "remoteId": "resgroup-1088",
    "environmentType": "ONPREM"
  }
]
```

```

        "type": "vCenter"
      },
      "remoteId": "resgroup-1953",
      "environmentType": "ONPREM"
    },
    {
      "links": [
        {
          "rel": "self",
          "href": "https://10.10.10.10/api/v3/entities/20b9e0acf4c6f7d5b00f744d1dc954616095f1f2?include_aspects=false"
        }
      ],
      "uuid": "20b9e0acf4c6f7d5b00f744d1dc954616095f1f2",
      "displayName": "ACM",
      "className": "VirtualDataCenter",
      "priceIndex": 1,
      "state": "ACTIVE",
      "severity": "Normal",
      "discoveredBy": {
        "uuid": "_lj_tkH39EeiKy53b3GBglA",
        "displayName": "vsphere-dc5.dev.mycorp.com",
        "type": "vCenter"
      },
      "remoteId": "resgroup-v1946",
      "environmentType": "ONPREM"
    },
    {
      "links": [
        {
          "rel": "self",
          "href": "https://10.10.10.10/api/v3/entities/56e6cfd2bc88ef5675df9dc3e06796ceb8b6e301?include_aspects=false"
        }
      ],
      "uuid": "56e6cfd2bc88ef5675df9dc3e06796ceb8b6e301",
      "displayName": "olga_do_not_touch_7",
      "className": "VirtualDataCenter",
      "priceIndex": 1,
      "state": "ACTIVE",
      "severity": "Normal",
      "discoveredBy": {
        "uuid": "_GRNtoNu0Eeilt9UDtI29QA",
        "displayName": "vsphere-dc7.dev.mycorp.com",
        "type": "vCenter"
      },
      "remoteId": "resgroup-1066",
      "environmentType": "ONPREM"
    }
  ]
}

```

Getting Settings of a Group

Referenced Endpoint: [Settings](#)

Gets both global and user-modified settings for the specified group. To get a single setting, pass the setting UUID as part of the request URL. This request takes the following parameters:

group_Uuid

The Uuid of the group whose settings will be returned

include_settingspolicies

Default: false. When true, returns the settings policies affecting the specified group, in addition to the settings.

Example: GET https://10.10.10.10/api/v3/groups/_WvaGk0BjEeierZ9b1bxmegg/settings?include_settingspolicies=false

Response: A list of SettingsManagerApiDTOs representing the settings, or settings and settings policies for the specified group:

```

[
  {
    "uuid": "appsettingsmanager",
    "displayName": "Application Discovery",

```



```

"category": "AppDiscovery",
"settings": [
  {
    "uuid": "Username",
    "displayName": "Username",
    "value": "",
    "defaultValue": "",
    "valueType": "STRING",
    "entityType": "VirtualMachine",
    "sourceGroupName": "Global"
  },
  {
    "uuid": "Password",
    "displayName": "Password",
    "value": "",
    "defaultValue": "",
    "valueType": "STRING",
    "entityType": "VirtualMachine",
    "sourceGroupName": "Global"
  },
  ...
],
{
  "uuid": "controlmanager",
  "displayName": "Action Workflow",
  "category": "Automation",
  "settings": [
    {
      "uuid": "moveVMWorkflow",
      "displayName": "Move Workflow",
      "value": "",
      "defaultValue": "",
      "valueType": "STRING",
      "entityType": "VirtualMachine",
      "sourceGroupName": "Global"
    }
  ]
}
...
}

```

Editing a Specified Setting of a Group

Referenced Endpoint: [Settings](#)

Edits a specified setting for the specified group. This request takes the following parameters:

group_Uuid

The Uuid of the group whose setting will be edited

settingsManager_Uuid

The Uuid of the settings manager whose setting will be edited

setting_Uuid

The Uuid of the setting to change

Example: PUT https://10.10.10.10/api/v3/groups/_WvaGk0BjEeierZ9b1bxmegg/settings/appsettingsmanager/Retry_Interval

Example Input:

The new value for the setting:

```

{
  "value": "61"
}

```

Response: A ServiceEntityApiDTO representing the specified setting, with your changed value(s):

```

{
  "uuid": "Retry_Interval",
  "displayName": "Retry Interval [mins]",
  "value": "61",
  "defaultValue": "60.0",

```

```

    "valueType": "NUMERIC",
    "min": 0,
    "max": 50000,
    "entityType": "VirtualMachine",
    "sourceGroupName": "A_Few_ACM_VMs"
  }

```

Getting Settings Policies of a Group

Referenced Endpoint: [Settings Policies](#)

Gets the settings policies of the specified group.

Example:

Response:

Getting Statistics of a Group

Referenced Endpoint: [Stats](#)

Gets all statistics for the specified group:

Note:

When you retrieve statistics for a cluster, using the /groups endpoint will return the aggregated statistics for all applicable cluster entities. For individual stats per entity, use the /stats endpoint.

Some statistics are only valid for certain scopes. When you request given statistics for a scope that doesn't include them, the API does not return any data. For example, the numVMs statistic is valid in only the Market and Cluster scopes – the API omits numVMs data from the response when you query other scopes.

Example: https://10.10.10.10/api/v3/groups/_WvaGk0BjEeierZ9b1bxmegg/stats

Response: A list of StatSnapshotApiDTOs representing the statistics for the specified group:

```

[
  {
    "displayName": "A_Few_ACM_VMs",
    "date": "2019-03-31T17:11:35-04:00",
    "statistics": [
      {
        "displayName": "(multiple)",
        "name": "priceIndex",
        "values": {
          "max": 1.44,
          "min": 1.03,
          "avg": 1.19,
          "total": 4.77
        },
        "value": 1.19
      },
      {
        "displayName": "(multiple)",
        "name": "Q1VCPU",
        "capacity": {
          "max": 20000,
          "min": 20000,
          "avg": 20000,
          "total": 60000
        },
        "reserved": {
          "max": 10000,
          "min": 10000,
          "avg": 10000,
          "total": 30000
        },
        "filters": [
          {
            "type": "relation",
            "value": "bought"
          }
        ]
      }
    ]
  }
]

```

```

    ...
  }
  ]
}

```

Getting a Filtered List of Statistics of a Group

Referenced Endpoint: [Stats](#)

Gets a filtered list of statistics for the specified group. For more information about creating a filtered list of statistics, including example POSTs and responses, see *Filtered Statistics* in the [Statistics Endpoint](#)

Example: POST https://10.10.10.10/api/v3/groups/_WvaGk0BjEeierZ9b1bxmegg/stats

Example input:

```

{
  "endDate": "-1d",
  "startDate": "-1w",
  "statistics": [
    {
      "filters": [
        {
          "type": "relation",
          "value": "bought"
        }
      ]
    }
  ]
}

```

Response: A list of StatSnapshotApiDTOs representing the statistics for the specified group:

```

[
  {
    "displayName": "A_Few_ACM_VMs",
    "date": "2019-03-24T00:00:00-04:00",
    "statistics": [
      {
        "name": "Mem",
        "capacity": {
          "max": 134214448,
          "min": 134214448,
          "avg": 134214448,
          "total": 1073715580
        },
        "filters": [
          {
            "type": "relation",
            "value": "bought"
          }
        ],
        "units": "KB",
        "values": {
          "max": 2073084,
          "min": 679782.1,
          "avg": 1124840.4,
          "total": 4499361.5
        },
        "value": 1124840.4
      },
      {
        "name": "MemAllocation",
        "capacity": {
          "max": 504346624,
          "min": 504346624,
          "avg": 504346624,
          "total": 4034772990
        },
        "filters": [
          {
            "type": "relation",
            "value": "bought"
          }
        ]
      }
    ]
  }
]

```

```

    ],
    "units": "KB",
    "values": {
      "max": 2073084,
      "min": 679782.1,
      "avg": 1124840.4,
      "total": 4499361.5
    },
    "value": 1124840.4
  },
  {
    "name": "Q1VCPU",
    "capacity": {
      "max": 20000,
      "min": 20000,
      "avg": 20000,
      "total": 120000
    },
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "values": {
      "max": 90,
      "min": 14,
      "avg": 41.08,
      "total": 123.23
    },
    "value": 41.08
  }
  ...
]

```

Getting the Supply Chain of a Group

Referenced Endpoint: [Supply Chains](#)

Using one or more of the following parameters, you can filter the supply chain that is returned by this request:

market_Uuid

The UUID of the market whose supply chain will be returned

types

The entity types whose supply chain will be returned. Choose from:

- BUSINESS_UNIT
- CLOUD_SERVICE
- CONTAINER
- DATABASE
- DATABASE_SERVER
- DATACENTER
- DISK_ARRAY
- PHYSICAL_MACHINE
- STORAGE
- VIRTUAL_MACHINE
- SWITCH
- VIRTUAL_DATACENTER
- CHASSIS
- STORAGE_CONTROLLER

- IO_MODULE
- APPLICATION_SERVER
- VIRTUAL_APPLICATION
- NETWORK
- APPLICATION
- CONTAINER
- CONTAINER_POD
- LOGICAL_POOL
- DPOD
- VPOD
- LOAD_BALANCER

entity_states

Only return entities in the specified states. Choose from:

- ACTIVE:

Entity is actively consuming resources.

- EVACUATED:

Entity is ready to suspend and will not participate in the market, but will not generate a SUSPEND action.

Note: This state replaces the SUSPEND state, and requires additional configuration to enable. Turbonomic does not recommend enabling this state.

- FAILOVER:

This entity is reserved for failover and will not participate in the market.

- IDLE:

Entity is powered off and not actively consuming market resources.

- LAUNCH:

Entity is starting.

- MAINTENANCE:

Entity is in maintenance mode.

- NOT_MONITORED:

Entity is not currently monitored by Turbonomic.

- QUEUED:

Entity is in the process of changing from one state to another.

Note: This state is internal to Turbonomic and will not appear in the UI, but may appear in an API response if the call is executed at the precise moment the entity is changing state.

- RESOURCE_ALLOCATION:

Cloud entity is being created.

- RESOURCE_RELEASE:

Cloud Entity is being deleted.

- SUSPEND:

Entity is suspended or the guest OS is in sleep, standby, or suspended state. The entity is not removed from the environment, but will not be used in market decisions. Based on market conditions, suspended entities can be started, re-adding them to the market.

- SUSPEND_PENDING:

Entity is making preparations to suspend, or is the next entity of its type to suspend.

- **TERMINATE_PENDING:**

Entity is in the process of being deleted.

- **UNKNOWN:**

Turbonomic is unable to obtain the current state of the entity.

This occurs when the entity is reported to the hypervisor as having a state of DISCONNECTED, ORPHANED, or INVALID.

environment_type

Only return actions that affect entities in the specified environment type. [CLOUD, HYBRID, ONPREM].

detail_type

The level of detail returned for each item in the returned supply chain. [compact, entity, aspects].

health

Return a small summary of the health of the returned supply chain.

Example: GET https://10.10.10.10/api/v3/groups/_WvaGk0BjEeierZ9b1bxmgg/supplychains?types=PhysicalMachine&entity_states=ACTIVE&entity_states=SUSPEND&entity_states=MAINTENANCE&environment_type=ONPREM&detail_type=entity&health=true

Response: A SupplychainApiDTO representing the supply chain of the specified group:

```
"seMap": {
  "PhysicalMachine": {
    "depth": 1,
    "entitiesCount": 3,
    "healthSummary": {
      "Minor": 1,
      "Normal": 2
    },
    "stateSummary": {
      "ACTIVE": 3
    },
    "connectedProviderTypes": [
      "DataCenter",
      "Storage"
    ],
    "instances": {
      "34313836-3333-5553-4537-33364e385146": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/34313836-3333-5553-4537-33364e385146?include_aspects=false"
          }
        ],
        "uuid": "34313836-3333-5553-4537-33364e385146",
        "displayName": "dc17-host-01.dev.mycorp.com",
        "className": "PhysicalMachine",
        "priceIndex": 3.2925103,
        "state": "ACTIVE",
        "severity": "Normal",
        "discoveredBy": {
          "uuid": "_yXCEIF6hEeiNCKdg4ZVvVQ",
          "displayName": "vsphere-dc17.dev.mycorp.com",
          "type": "vCenter"
        },
        "remoteId": "host-621",
        "environmentType": "ONPREM"
      },
      ...
    ]
  }
}
```

```
}
```

Groups Endpoint Tips

GroupBy Field Criteria

When using the POST requests to query actions and action statistics, you can use the `groupBy` parameter to organize the results. The valid values for this parameter differ by entity type:

Note:

When sending an inputDTO using this field, only the value is needed.

Example: "groupBy": "vmsByPMName"

```
{
  "VirtualMachine":{
    "criteria":[
      {
        "filterType":"vmsByName"
      },
      {
        "filterType":"vmsByPMName"
      },
      {
        "filterType":"vmsByStorage"
      },
      {
        "filterType":"vmsByNetwork"
      },
      {
        "filterType":"vmsByApplication"
      },
      {
        "filterType":"vmsByDatabaseServer"
      },
      {
        "filterType":"vmsByDatabaseServerVersion"
      },
      {
        "filterType":"vmsByDC"
      },
      {
        "filterType":"vmsByVDC"
      },
      {
        "filterType":"vmsByDCnested"
      },
      {
        "filterType":"vmsByNumCPUs"
      },
      {
        "filterType":"vmsByMem"
      },
      {
        "filterType":"vmsByGuestName"
      },
      {
        "filterType":"vmsByAltName"
      },
      {
        "filterType":"vmsByClusterName"
      },
      {
        "filterType":"vmsByDiskArrayName"
      },
      {
        "filterType":"vmsByLogicalPoolName"
      },
      {
        "filterType":"vmsByProfileName"
      },
      {
        "filterType":"vmsByTag"
      }
    ]
  }
}
```

```

    {
      "filterType": "vmsByState"
    },
    {
      "filterType": "vmsByBusinessAccountUuid"
    },
    {
      "filterType": "vmsByResourceGroupUuid"
    }
  ]
},
"VirtualDataCenter": {
  "criteria": [
    {
      "filterType": "vdcsByName"
    },
    {
      "filterType": "vdcsByVDCName"
    },
    {
      "filterType": "vdcsByTag"
    },
    {
      "filterType": "vdcsByState"
    }
  ]
},
"PhysicalMachine": {
  "criteria": [
    {
      "filterType": "pmsByName"
    },
    {
      "filterType": "pmsByStorage"
    },
    {
      "filterType": "pmsByNetwork"
    },
    {
      "filterType": "pmsBySwitch"
    },
    {
      "filterType": "pmsByNumVms"
    },
    {
      "filterType": "pmsByDC"
    },
    {
      "filterType": "pmsByMem"
    },
    {
      "filterType": "pmsByNumCPUs"
    },
    {
      "filterType": "pmsByVendorName"
    },
    {
      "filterType": "pmsByCPUModel"
    },
    {
      "filterType": "pmsByModel"
    },
    {
      "filterType": "pmsByTimezone"
    },
    {
      "filterType": "pmsByClusterName"
    },
    {
      "filterType": "pmsByTag"
    },
    {
      "filterType": "pmsByState"
    }
  ]
},
"Storage": {
  "criteria": [
    {
      "filterType": "storageByName"
    },
    {

```



```

        "filterType": "storageByTag"
      },
      {
        "filterType": "storageByVMs"
      },
      {
        "filterType": "storageByDC"
      },
      {
        "filterType": "storageByPMCluster"
      },
      {
        "filterType": "storageByState"
      }
    ]
  },
  "Application": {
    "criteria": [
      {
        "filterType": "appsByName"
      },
      {
        "filterType": "appsByTag"
      }
    ]
  },
  "ApplicationComponent": {
    "criteria": [
      {
        "filterType": "appSrvsByName"
      }
    ]
  },
  "WebServer": {
    "criteria": [
      {
        "filterType": "wbSrvsByName"
      }
    ]
  },
  "BusinessApplication": {
    "criteria": [
      {
        "filterType": "busAppsByName"
      }
    ]
  },
  "Database": {
    "criteria": [
      {
        "filterType": "databaseByName"
      },
      {
        "filterType": "databaseByTag"
      },
      {
        "filterType": "databaseByBusinessAccountUuid"
      },
      {
        "filterType": "databaseByResourceGroupUuid"
      }
    ]
  },
  "DatabaseServer": {
    "criteria": [
      {
        "filterType": "databaseServerByName"
      },
      {
        "filterType": "databaseServerByTag"
      },
      {
        "filterType": "databaseServerByBusinessAccountUuid"
      },
      {
        "filterType": "databaseServerByEngine"
      },
      {
        "filterType": "databaseServerByEdition"
      },
      {
        "filterType": "databaseServerByVersion"
      }
    ]
  }
}

```

```

    }
  ]
},
"VirtualApplication":{
  "criteria":[
    {
      "filterType":"vappsByName"
    }
  ]
},
"Cluster":{
  "criteria":[
    {
      "filterType":"clustersByName"
    },
    {
      "filterType":"clustersByTag"
    }
  ]
},
"DataCenter":{
  "criteria":[
    {
      "filterType":"datacentersByName"
    },
    {
      "filterType":"datacentersByTag"
    }
  ]
},
"Group":{
  "criteria":[
    {
      "filterType":"groupsByName"
    },
    {
      "filterType":"groupsByTargetName"
    }
  ]
},
"StorageCluster":{
  "criteria":[
    {
      "filterType":"storageClustersByName"
    }
  ]
},
"DiskArray":{
  "criteria":[
    {
      "filterType":"diskarrayByName"
    }
  ]
},
"Zone":{
  "criteria":[
    {
      "filterType":"zonsByName"
    }
  ]
},
"Region":{
  "criteria":[
    {
      "filterType":"regsByName"
    }
  ]
},
"Network":{
  "criteria":[
    {
      "filterType":"netsByName"
    }
  ]
},
"LoadBalancer":{
  "criteria":[
    {
      "filterType":"lbsByName"
    }
  ]
},
},

```

```

"Chassis":{
  "criteria":[
    {
      "filterType":"chasByName"
    }
  ]
},
"IOModule":{
  "criteria":[
    {
      "filterType":"ioModuleByName"
    }
  ]
},
"StorageController":{
  "criteria":[
    {
      "filterType":"storagecontrollerByName"
    }
  ]
},
"DPod":{
  "criteria":[
    {
      "filterType":"dpodByName"
    }
  ]
},
"VPod":{
  "criteria":[
    {
      "filterType":"vpodByName"
    }
  ]
},
"LogicalPool":{
  "criteria":[
    {
      "filterType":"logicalPoolByName"
    }
  ]
},
"Switch":{
  "criteria":[
    {
      "filterType":"switchByName"
    }
  ]
},
"Container":{
  "criteria":[
    {
      "filterType":"containersByName"
    },
    {
      "filterType":"containersByVMName"
    }
  ]
},
"ContainerPod":{
  "criteria":[
    {
      "filterType":"containerpodsByName"
    },
    {
      "filterType":"containerpodsByVMName"
    }
  ]
},
"ServiceEntity":{
  "criteria":[
    {
      "filterType":"workloadByBusinessAccountUuid"
    },
    {
      "filterType":"workloadByResourceGroupUuid"
    }
  ]
},
"Workload":{
  "criteria":[
    {

```

```

        "filterType": "workloadByBusinessAccountUuid"
      },
      {
        "filterType": "workloadByResourceGroupUuid"
      }
    ]
  },
  "ResourceGroup": {
    "criteria": [
      {
        "filterType": "resourceGroupByName"
      },
      {
        "filterType": "resourceGroupByUuid"
      },
      {
        "filterType": "resourceGroupByBusinessAccountUuid"
      },
      {
        "filterType": "resourceGroupByTag"
      }
    ]
  },
  "BusinessAccount": {
    "criteria": [
      {
        "filterType": "businessAccountByName"
      },
      {
        "filterType": "businessAccountByUuid"
      },
      {
        "filterType": "subBusinessAccountOfUuid"
      },
      {
        "filterType": "businessAccountValidationStatus"
      },
      {
        "filterType": "businessAccountTargetName"
      },
      {
        "filterType": "businessAccountCloudProvider"
      }
    ]
  },
  "BillingFamily": {
    "criteria": [
      {
        "filterType": "billingFamilyByName"
      }
    ]
  },
  "ViewPod": {
    "criteria": [
      {
        "filterType": "viewPodByName"
      }
    ]
  },
  "DesktopPool": {
    "criteria": [
      {
        "filterType": "desktopPoolByName"
      },
      {
        "filterType": "desktopPoolByViewPod"
      }
    ]
  },
  "BusinessUser": {
    "criteria": [
      {
        "filterType": "businessUserByName"
      },
      {
        "filterType": "businessUserByDesktopPool"
      }
    ]
  }
}

```

Licenses Endpoint

A product license determines the product features you can use, and the number of workloads that you can manage with Turbonomic. To increase the number of workloads you can manage, you can add additional licenses to your Turbonomic installation. Note that if you use multiple licenses, they must all support the same feature set.

In all circumstances, you should contact your sales representative to make sure that you get the correct license, and that you know how to install it properly.

Using the licenses endpoint, you can:

- Get a license summary
- Get a list of licenses currently added to your Turbonomic appliance
- Add a license
- Delete a license

Licenses Requests

Getting Licenses

Gets a list of licenses. For instances with multiple licenses, the `licenses/summary` request will return a summed total of licensed workload. For example, if you have two licenses for 10,000 workloads each, the `/licenses` request will return both `LicenseApiDTOs` in a list. The `/licenses/summary` call will return a single summed `LicenseApiDTO`, which will state that you have capacity for 20,000 workloads.

Examples:

- **List of Licenses:** GET `https://10.10.10.10/api/v3/licenses`
- **License Summary:** GET `https://10.10.10.10/api/v3/licenses/summary`

Adding a License

Adds a license to your Turbonomic installation. You may optionally specify the `dryRun` parameter which, when set to true, will validate the license file but not apply it to the appliance.

Note:

This request requires a multipart file as input. Due to this requirement, this request cannot be executed directly from the Swagger.

Example: POST `https://10.10.10.10/api/v3/licenses?file=%5Bobject%20File%5D&dryRun=true`

Deleting a License

Removes the specified license from your Turbonomic installation. Deleting a license may reduce your licensed workload capacity below your current usage. In this case, you will be unable to add more targets until more workload capacity is available.

Example: DELETE `https://10.10.10.10/api/v3/licenses/_I_WVcJtWEeiGEs_doVlD0w`

Markets Endpoint

Turbonomic uses market-based analysis to perform workload management. To do this, it constructs a model of your environment, representing each entity as a buyer and seller in a market. You can access this model via a named market resource. There are two types of markets:

- **Real-Time Market**

The real-time market performs analysis and workload management on your environment. You can use the real-time market to access entities and get current or historical data about them.

The `displayName` of the real-time market is `Market`. This market should always be in the `RUNNING` state. You should not attempt to use the API to stop this market.

Turbonomic performs discovery to populate the topology it manages (the collection of entities in the real-time market). For this reason, you should never use the API add or delete entities in the real-time market.

- **Plan Market**

A plan market begins as a snapshot of the real-time market. You POST a scenario to the real-time market, and Turbonomic makes a copy of the real-time market to create a plan market. This plan market is just like the real-time market, except for any changes that were declared in the scenario. For example, if the scenario declares a scope for the plan, then the plan market only contains entities that are within that scope.

Turbonomic runs economic cycles (buy/sell cycles) against this plan market until there are no more meaningful improvements to be made. At this point the plan run is completed.

Note that once Turbonomic creates the plan market, that market stays in memory until you delete it. Also note that you can later apply a scenario to the plan market. This is how you run a plan on a plan. The logic flow is the same, and Turbonomic creates yet another plan market to run the analysis.

This endpoint contains references to start and end times for certain operations. For more information, including valid time formats, see [Time in the Turbonomic API](#)

Using the markets endpoint of the Turbonomic API, you can:

- Get a list of markets
- Save or Stop a plan market
- Delete a plan market
- See unplaced entities in a plan market
- Get filtered and unfiltered lists of actions, entities, notifications, policies, reservations, and statistics for a particular market
- Get, edit, and delete placement policies in the real-time market

Determining the Status of the Main Market

After restarting the Turbonomic instance, the UI and API may be available before the real-time market has finished initializing and loading the topology of your environment. To check market status, execute the `GET /markets/market_uuid` request with a market UUID of `Market`.

If information about the market is returned, it has initialized. If the real-time market is not initialized, the following response will be returned:

```
{
  "type": 400,
  "exception": "com.vmturbo.api.exceptions.OperationFailedException: Infrastructure is not
controlled yet. Could not get market.",
  "message": "Infrastructure is not controlled yet. Could not get market."
}
```

Markets Requests

Getting a List of Markets

Returns all the Markets currently stored on your Turbonomic appliance. To get the details of a single market, include the UUID of the market in the request.

Note:

One market will have the `displayName` of *Market*. This market is the real-time market. You should not add nor delete entities directly to this market using the API, nor should you attempt to execute a STOP action on this market.

Examples:

- All Markets: GET <https://10.10.10.10/api/v3/markets>
- Single Market: GET https://10.10.10.10/api/v3/markets/_0x30YUg1Ed-gHc4L513y0A

Response: A list of `MarketApiDTO`s representing the markets on your appliance.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/markets/_0x30YUg1Ed-gHc4L513y0A"
      }
    ],
    "uuid": "_0x30YUg1Ed-gHc4L513y0A",
    "displayName": "Market",
    "className": "Market",
    "state": "RUNNING",
    "unplacedEntities": false,
    "environmentType": "HYBRID"
  },
  ...
]
```

Stopping or Saving Plan Markets

For troubleshooting, you may need to stop or save a plan market that is taking a long time to run, or does not seem to complete. These operations should never be used on the real-time market. Note that a manually-stopped plan market may have incomplete data.

This request takes the following parameters:

market_Uuid

The UUID of the market that will be stopped or saved.

operation

The operation to perform on the market. [stop, save]

Example: POST https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw?operation=stop

Response: The `MarketApiDTO` of the specified market, showing its state as STOPPING.

```
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw"
    },
    {
      "rel": "Market notifications",
      "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw/notifications"
    },
    {
      "rel": "Market actions",
      "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw/actions?ascending=true"
    },
    {
      "rel": "To Entities",
      "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw/entities"
    },
    {
      "rel": "To Constraints",
      "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw/policies"
    },
    {
      "rel": "To Reservations",

```

```

    "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw/reservations"
  },
  {
    "rel": "To Statistics",
    "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw/stats"
  },
  {
    "rel": "To Unplaced Entities",
    "href": "https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw/unplacedentities"
  },
  {
    "rel": "To Market List",
    "href": "https://10.10.10.10/api/v3/markets"
  }
],
"uuid": "_N08_sCi_EemDHtuQzfdzxw",
"displayname": "ADD_WORKLOAD_administrator_1549313730114",
"classname": "Market",
"state": "STOPPING",
"scenario": {
  "uuid": "2452690315520",
  "displayname": "Add Workload 1",
  "owners": [],
  "type": "ADD_WORKLOAD"
},
"unplacedEntities": false,
"runDate": "2019-02-04T15:55:30-05:00",
"environmentType": "ONPREM"
}

```

Deleting a Plan Market

Deleting a plan market removes the market entity along with all the topological links, such as actions, notifications, entities, policies and reservations. This operation is permanent. To delete a plan market, pass the UUID of the market in the request.

This request takes the following parameters:

market_Uuid

The UUID of the market that will be deleted.

Example: DELETE https://10.10.10.10/api/v3/markets/_N08_sCi_EemDHtuQzfdzxw

Response: The MarketApiDTO of the specified market, showing its state as DELETING.

```

{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/markets/2452692215536"
    }
  ],
  "uuid": "2452692215536",
  "displayname": "ADD_WORKLOAD_administrator_1549313730114",
  "classname": "Market",
  "state": "DELETING",
  "scenario": {
    "uuid": "2452692204928",
    "displayname": "Add Workload 1",
    "owners": [
      {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/users/_4T_7kwY-Ed-WUKbEYSVIDw"
          }
        ],
        "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
        "displayname": "Administrator User",
        "username": "administrator",
        "roleUuid": "_4UAioQY-Ed-WUKbEYSVIDw",
        "roleName": "administrator",
        "loginProvider": "Local",
        "type": "DedicatedCustomer",
        "showSharedUserSC": false
      }
    ]
  }
}

```



```

    ],
    "type": "ADD_WORKLOAD"
  },
  "saved": true,
  "unplacedEntities": false,
  "runDate": "2019-02-04T15:55:30-05:00",
  "runCompleteDate": "2019-02-04T15:57:26-05:00",
  "environmentType": "ONPREM"
}

```

Getting a Filtered List of Actions for a Market

Referenced Endpoint: [Actions](#)

Gets a list of actions, given a market UUID and filtered by an ActionApiInputDTO using one or more of the following criteria:

actionModelList

- **DISABLED:**
Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.
- **RECOMMENDED:**
Recommend the action so a user can execute it via the given hypervisor or by other external means
- **MANUAL:**
Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.
- **AUTOMATED:**
You have directed Turbonomic to execute the action automatically.
- **COLLECTION (UNUSED):**
Legacy action mode, no longer used.

actionStateList

- **DISABLED:**
An action whose policy has been disabled.
- **RECOMMEND:**
An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.
- **PENDING_ACCEPT:**
When the action mode is set to manual, a recommended action that has not been accepted or cleared.
- **ACCEPTED:**
An action that has been accepted, but is not yet in progress.
- **IN_PROGRESS:**
An action that is being executed.
- **SUCCEEDED:**
An action that was accepted and completed successfully.
- **FAILED:**
An action that was accepted and did not complete successfully.
- **REJECTED:**

When the action mode is set to manual, an action that has been rejected by the user.

- **CLEARED:**

When the action mode is set to manual, an action that is no longer recommended by the market.

- **ACCOUNTING:**

For cloud entities, an action to resize in order to use a different instance template.

- **QUEUED:**

When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

actionTypeList

- **START:**

Start an entity, and add it to the Turbonomic market.

- **MOVE:**

Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.

- **SUSPEND:**

Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.

- **ADD PROVIDER:**

This is equivalent to the START action, but for storage entities.

- **CHANGE:**

Move a virtual machine's storage between datastores.

- **PROVISION:**

Add capacity to your environment.

- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

cleared

Default: false.

When true, actions that were removed from the action list before being executed will be returned.

costType

- Saving

An action that will decrease cloud spending.

- Investment

An action that will increase cloud spending.

cumulative

Default: false.

When true, shows the savings for each action in a scope as a cumulative total, rather than showing the savings for individual actions.

environmentType

- ONPREM:

Returns only actions related to entities that are part of your on-premises environment.

- CLOUD:

Returns only actions related to entities that are part of your cloud environment.

groupBy

You may group the actions returned by the following criteria: [actionModes, actionStates, actionTypes, risk, riskSeverity, riskSubCategory]

hasReservedInstance

Default: false.

When true, only actions that are related to reserved instances will be returned.

relatedEntityTypes

Returns only actions related to entities of these types within the scope. For example, if your scope is a virtual datacenter and you specify VirtualMachine as a related entity type, the request will include only those actions related to VMs in the specified virtual datacenter.

Choose from the following entity types: [Datacenter, PhysicalMachine, VirtualMachine, Storage, Application, Chassis, DiskArray, IOModule, StorageControl, Switch, VirtualDataCenter, VPod, DPod, Container, Database, DatabaseServerContainer, LogicalPool]

riskSeverityList

Returns only actions of the given severities: [Unknown, Normal, Minor, Major, Critical]

riskSubCategoryList

returns only actions of the given subcategories: [Performance Assurance, Efficiency Improvement, Prevention, Compliance]

This request takes the following parameters:

market_Uuid

The UUID of the market whose actions will be returned.

cursor

When making subsequent calls to retrieve additional results, this is the cursor returned by the last call to this method.

limit

The maximum number of items to return. Must be a positive integer. If not set, the server will provide a default (20).

order_by

The field to order the results by. [`creation_date`, `name`, `risk_category`, `savings`, `severity`].

ascending

Default: true. When false, results will be in descending order.

Example: POST `https://10.10.10.10/api/v3/markets/Market/actions?order_by=severity&ascending=true`

Example input: In this example, a list of actions that meet the following criteria will be returned and grouped by the `actionMode` of the action, in order of severity:

- Is in state `PENDING_ACCEPT`
- Is part of an on-premises environment
- Is an action for a virtual machine
- Is an action generated by the Turbonomic real-time market

```
{
  "actionInput": {
    "actionStateList": [
      "PENDING_ACCEPT"
    ],
    "environmentType": "ONPREM",
    "groupBy": [
      "actionModes"
    ]
  },
  "relatedType": "VirtualMachine",
  "scopes": [
    "Market"
  ]
}
```

Response: ActionApiDTOs meeting the specified criteria.

```
{
  ..
  "uuid": "_qFuM8Ci0EemDHtuQzfdzxw",
  "createTime": "2019-02-04T10:07:58-05:00",
  "actionType": "RIGHT_SIZE",
  "actionState": "PENDING_ACCEPT",
  "actionMode": "MANUAL",
  "details": "Scale VirtualMachine 8f0e3136-b259-43e5-41f8-0d2c64c62acc from Standard_B2ms to Standard_E2s_v3",
  "importance": 0,
  ...
}
```

Getting Statistics for a Filtered List of Actions for a Market

Referenced Endpoint: [Actions](#)

Referenced Endpoint: [Stats](#)

Gets a list of statistics for a filtered list of actions. Statistics returned include the number of actions, total savings/investment, and the number of entities affected by the actions. In addition to the Market UUID, provide an ActionApiInputDTO using one or more of the following criteria:

actionModeList

- DISABLED:

Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.

- **RECOMMENDED:**

Recommend the action so a user can execute it via the given hypervisor or by other external means

- **MANUAL:**

Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.

- **AUTOMATED:**

You have directed Turbonomic to execute the action automatically.

- **COLLECTION (UNUSED):**

Legacy action mode, no longer used.

actionStateList

- **DISABLED:**

An action whose policy has been disabled.

- **RECOMMEND:**

An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.

- **PENDING_ACCEPT:**

When the action mode is set to manual, a recommended action that has not been accepted or cleared.

- **ACCEPTED:**

An action that has been accepted, but is not yet in progress.

- **IN_PROGRESS:**

An action that is being executed.

- **SUCCEEDED:**

An action that was accepted and completed successfully.

- **FAILED:**

An action that was accepted and did not complete successfully.

- **REJECTED:**

When the action mode is set to manual, an action that has been rejected by the user.

- **CLEARED:**

When the action mode is set to manual, an action that is no longer recommended by the market.

- **ACCOUNTING:**

For cloud entities, an action to resize in order to use a different instance template.

- **QUEUED:**

When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

actionTypeList

- **START:**

Start an entity, and add it to the Turbonomic market.

- **MOVE:**

Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.

- **SUSPEND:**

Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.

- **ADD PROVIDER:**

This is equivalent to the START action, but for storage entities.

- **CHANGE:**

Move a virtual machine's storage between datastores.

- **PROVISION:**

Add capacity to your environment.

- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR_EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR_PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

cleared

Default: false.

When true, actions that were removed from the action list before being executed will be returned.

costType

- **Saving**

An action that will decrease cloud spending.

- **Investment**

An action that will increase cloud spending.

cumulative

Default: false.

When true, shows the savings for each action in a scope as a cumulative total, rather than showing the savings for individual actions.

environmentType

- **ONPREM:**

Returns only actions related to entities that are part of your on-premises environment.

- **CLOUD:**

Returns only actions related to entities that are part of your cloud environment.

groupBy

You may group the actions returned by the following criteria: [actionModes, actionStates, actionTypes, risk, riskSeverity, riskSubCategory]

hasReservedInstance

Default: false.

When true, only actions that are related to reserved instances will be returned.

relatedEntityTypes

Returns only actions related to entities of these types within the scope. For example, if your scope is a virtual datacenter and you specify VirtualMachine as a related entity type, the request will include only those actions related to VMs in the specified virtual datacenter.

Choose from the following entity types: [Datacenter, PhysicalMachine, VirtualMachine, Storage, Application, Chassis, DiskArray, IOModule, StorageControl, Switch, VirtualDataCenter, VPod, DPod, Container, Database, DatabaseServerContainer, LogicalPool]

riskSeverityList

Returns only actions of the given severities: [Unknown, Normal, Minor, Major, Critical]

riskSubCategoryList

returns only actions of the given subcategories: [Performance Assurance, Efficiency Improvement, Prevention, Compliance]

Example: POST https://10.10.10.10/api/v3/markets/Market/actions/stats

Example input: In this example, a list of actions that meet the following criteria will be returned and grouped by the actionMode of the action, in order of severity:

- Is in state PENDING_ACCEPT
- Is part of an on-premises environment
- Is an action for a virtual machine
- Is an action generated by the Turbonomic real-time market

```
{
  "actionInput": {
    "actionStateList": [
      "PENDING_ACCEPT"
    ],
    "environmentType": "ONPREM",
    "groupBy": [
      "actionModes"
    ]
  },
  "relatedType": "VirtualMachine",
  "scopes": [
    "Market"
  ]
}
```

Response: A list of StatSnapshotApiDTO containing statistics about the filtered actions.

```
[
  {
    "date": "2019-02-05T14:40:08-05:00",
    "statistics": [
      {
        "name": "numActions",
```

```

        "values":{
          "max":268,
          "min":268,
          "avg":268,
          "total":268
        },
        "value":268
      },
      {
        "name":"costPrice",
        "filters":[
          {
            "type":"property",
            "value":"savings"
          }
        ],
        "units":"$",
        "values":{
          "max":24100,
          "min":24100,
          "avg":24100,
          "total":24100
        },
        "value":24100
      },
      ...
    ]
  }
]

```

Getting All Entities Within a Market

Referenced Endpoint: [Entities](#)

Gets a list of all entities in the specified market. This request may be used to retrieve a list of entities used in a plan market.

Example: GET <https://10.10.10.10/api/v3/markets/2452692215536/entities>

Response: A list of ServiceEntityApiDTOs, representing the entities in the market. In this case, note that there is an attribute entitled `realtimeMarketReference` because these are entities from a plan market.

```

[
  {
    "links":[
      {
        "rel":"self",
        "href":"https://10.10.10.10/api/v3/entities/_QQVtEyi_EemDHtuQzfdzxw?include_aspects=false"
      }
    ],
    "uuid":"_QQVtEyi_EemDHtuQzfdzxw",
    "displayName":"osp-master-2",
    "className":"VirtualMachine",
    "priceIndex":3.6063216,
    "state":"ACTIVE",
    "severity":"Normal",
    "realtimeMarketReference":{
      "uuid":"42000c5d-9ae5-44f0-252c-daabbb423a86"
    },
    "environmentType":"ONPREM"
  },
  ...
]

```

Getting Statistics of Entities Within a Market

Referenced Endpoint: [Stats](#)

Referenced Endpoint: [Entities](#)

Gets statistics related to entities in a specified market. For example, this request may be used to see the final calculated statistics for entities in a plan market. For more information about creating a filtered list of statistics, including example POSTs and responses, see *Filtered Statistics* in the [Statistics Endpoint](#).

Getting Statistics of a Specified Group of Entities Within a Market

Referenced Endpoint: [Stats](#)

Referenced Endpoint: [Groups](#)

Referenced Endpoint: [Entities](#)

Gets statistics related to a specific group of entities in a specified market. For example, this request may be used to see the final calculated statistics for a group of hosts in a plan market. For more information about creating a filtered list of statistics, including example POSTs and responses, see *Filtered Statistics* in the [Statistics Endpoint](#).

Getting Policies for a Market

Referenced Endpoint: [Policies](#)

Returns a list of all current policies affecting a specified market. For a plan market, this is a list of policies that you created, enabled, disabled, or changed in the plan configuration. For the real-time market, this is a list of policies currently available on your appliance. To get a single policy, include the UUID of the policy in the request.

Examples:

- All policies: GET `https://10.10.10.10/api/v3/markets/2481646239616/policies`
- One policy:

```
GET https://10.10.10.10/api/v3/markets/2481646239616/policies/_z3LKSTk0EemeycL7hWgJNw
```

Response: A list of `PolicyApiDTOs` representing the policies requested.

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/policies/_z3LxVzk0EemeycL7hWgJNw"
      }
    ],
    "uuid": "_z3LxVzk0EemeycL7hWgJNw",
    "displayName": "DalTestPolMerge",
    "type": "MERGE",
    "name": "DalTestPolMerge",
    "enabled": true,
    "commodityType": "ClusterCommodity",
    "mergeType": "Cluster",
    "mergeGroups": [
      {
        "uuid": "91ff08749fd278925d73b61b0f0f69d79c99fc3a",
        "displayName": "PMs_Beta_DC6\\Cluster-1",
        "className": "Group",
        "groupType": "PhysicalMachine",
        "isStatic": true,
        "logicalOperator": "AND"
      },
      {
        "uuid": "8c17d8e79c3db85ed5d3868de622cb89187849ce",
        "displayName": "PMs_Beta_DC6\\Cluster-2",
        "className": "Group",
        "groupType": "PhysicalMachine",
        "isStatic": true,
        "logicalOperator": "AND"
      }
    ]
  }
],
{
  "links": [
```

```

    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/policies/_z3LKSTk0EemeycL7hWgJNw"
    }
  ],
  "uuid": "_z3LKSTk0EemeycL7hWgJNw",
  "displayName": "CommSegmentation/SegmentManager__4T_7kwY-Ed-WUKbEYSVIDw_1551123454966",
  "type": "MUST_RUN_TOGETHER",
  "name": "CommSegmentation/SegmentManager__4T_7kwY-Ed-WUKbEYSVIDw_1551123454966",
  "enabled": false,
  "capacity": 1000000000,
  "commodityType": "DrsSegmentationCommodity",
  "consumerGroup": {
    "uuid": "_z2M57Dk0EemeycL7hWgJNw",
    "displayName": "Buyers-Group-GROUP-DRS-KTG-rule/DC13-Cluster/vsphere-
dc13.dev.mycorp.com",
    "className": "DiscoveredGroup",
    "groupType": "VirtualMachine",
    "isStatic": true,
    "logicalOperator": "AND"
  },
  "providerGroup": {
    "uuid": "_z2M57zk0EemeycL7hWgJNw",
    "displayName": "Sellers-Group-GROUP-DRS-KTG-rule/DC13-Cluster/vsphere-
dc13.dev.mycorp.com",
    "className": "DiscoveredGroup",
    "groupType": "PhysicalMachine",
    "isStatic": true,
    "logicalOperator": "AND"
  }
},
...
]

```

Deleting a Placement Policy for a Market

Referenced Endpoint: [Policies](#)

Deletes the specified policy, given the UUID of the policy and the market. Note that if you delete an imported policy, it will reappear after the next discovery cycle of the target it was imported from. To delete imported policies, delete them on the target directly.

Example: DELETE https://10.10.10.10/api/v3/markets/2481646239616/policies/_z3LxVzk0EemeycL7hWgJNw

Response: A successful deletion request returns a Response Code of 200.

Getting Reservations for a Market

Referenced Endpoint: [Reservations](#)

Returns a list of all current reservations for a specified market. For the real-time market, this is a list of reservations currently active on your appliance.

Example: GET <https://10.10.10.10/api/v3/markets/Market/reservations>

Response: A list of DemandReservationApiDTOs representing any current reservations.

```

[
  {
    "uuid": "_I6z38Tk8EemeycL7hWgJNw",
    "displayName": "DalRes2",
    "count": 1,
    "status": "RESERVED",
    "reserveDateTime": "Mon Feb 25 15:30:07 EST 2019",
    "expireDateTime": "Mon Mar 25 08:29:54 EDT 2019",
    "deployDateTime": "Tue Mar 26 08:29:54 EDT 2019",
    "reserveCount": 1,
    "deployCount": 0,
    "demandEntities": [
      {
        "uuid": "_JEZRwTk8EemeycL7hWgJNw",
        "displayName": "DalRes2_C0",
        "className": "VirtualMachine",

```

```

"template":{
  "uuid":"T-ef47f3dbdde39f888052332cbe7d0cf2",
  "displayName":"AVG:PMs_ACM\\ACM Cluster for last 10 days",
  "className":"VirtualMachineProfile"
},
"placements":{
  "computeResources":[
    {
      "stats":[
        {
          "name":"numOfCpu",
          "value":2
        },
        {
          "name":"cpuSpeed",
          "units":"MHz",
          "value":5320
        },
        {
          "name":"cpuConsumedFactor",
          "units":"%",
          "value":4.2516437
        },
        {
          "name":"memorySize",
          "units":"MB",
          "value":6631
        },
        {
          "name":"memoryConsumedFactor",
          "units":"%",
          "value":46.328953
        },
        {
          "name":"ioThroughput",
          "units":"MB/s",
          "value":0.05301181
        },
        {
          "name":"networkThroughput",
          "units":"MB/s",
          "value":0.103116125
        }
      ],
      "provider":{
        "uuid":"30333436-3638-5355-4532-313159335631",
        "displayName":"hp-dl571.dev.mycorp.com",
        "className":"PhysicalMachine"
      }
    }
  ],
  "storageResources":[
    {
      "stats":[
        {
          "name":"diskSize",
          "units":"GB",
          "value":92.468285
        },
        {
          "name":"diskIops",
          "value":1.6827557
        }
      ],
      "provider":{
        "uuid":"5a822e24-584bce98-ecb2-441ea15e2534",
        "displayName":"SCIO:ESXDC11DS2",
        "className":"Storage"
      }
    }
  ]
}
]
}
]

```

Running a Scenario on a Market

Referenced Endpoint: [Scenarios](#)

When you run a scenario on the real-time market, it creates a plan market showing the results of the scenario. If you run a second scenario a plan market, that is called running a "plan over plan". This runs a plan new configuration on a market that is already the result of a plan run.

Example: POST https://10.10.10.10/api/v3/markets/Market/scenarios/2452690315520?ignore_constraints=false

Response: A MarketApiDTO showing the new state of the market- if successful, COPYING.

```
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw"
    },
    {
      "rel": "Market notifications",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw/notifications"
    },
    {
      "rel": "Market actions",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw/actions?ascending=true"
    },
    {
      "rel": "To Entities",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw/entities"
    },
    {
      "rel": "To Constraints",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw/policies"
    },
    {
      "rel": "To Reservations",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw/reservations"
    },
    {
      "rel": "To Statistics",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw/stats"
    },
    {
      "rel": "To Unplaced Entities",
      "href": "https://10.10.10.10/api/v3/markets/_ps_iUDlBEemeycL7hWgJNw/unplacedentities"
    },
    {
      "rel": "To Market List",
      "href": "https://10.10.10.10/api/v3/markets"
    }
  ],
  "uuid": "_ps_iUDlBEemeycL7hWgJNw",
  "displayName": "API_Plan_Market",
  "className": "Market",
  "state": "COPYING",
  "scenario": {
    "uuid": "2452690315520",
    "displayName": "Add Workload 1",
    "owners": [
    ],
    "type": "ADD_WORKLOAD"
  },
  "unplacedEntities": false,
  "runDate": "2019-02-25T16:09:34-05:00",
  "environmentType": "ONPREM"
}
```

Getting Statistics for a Market

Referenced Endpoint: [Stats](#)

Gets statistics about the specified market. This call can be used to see statistics from the real-time market, or to see the resultant statistics in a plan market after the scenario has been applied.

Example: GET <https://10.10.10.10/api/v3/markets/Market/stats>

Response: A list of StatSnapshotApiDTOs representing the statistics of the real-time market.

```
[
  {
    "displayName": "PMs",
    "date": "2019-02-23T00:00:00-05:00",
    "statistics": [
      {
        "name": "CPUHeadroom",
        "capacity": {
          "max": 8610,
          "min": 0,
          "avg": 1602.22,
          "total": 14420
        },
        "units": "VM",
        "values": {
          "max": 8595,
          "min": 0,
          "avg": 1571.44,
          "total": 14143
        },
        "value": 1571.44
      },
      {
        "name": "CPUExhaustion",
        "units": "Day",
        "values": {
          "max": 2147483650,
          "min": 0,
          "avg": 2147483650,
          "total": 2147483650
        },
        "value": 2147483650
      },
      ...
    ]
  },
  ...
]
```

Getting a Filtered List of Statistics for a Market

Referenced Endpoint: [Stats](#)

Gets a list of statistics about the specified market, filtered by the criteria in the StatPeriodApiInputDTO you must pass as an inputDTO to this request. For more information about creating a filtered list of statistics, including example POSTs and responses, see *Filtered Statistics* in the [Statistics Endpoint](#).

Example:

Example Input:

Response: An array of StatSnapshotApiDTOs representing the filtered statistics for the market.

Getting the Supply Chain for a Market

Referenced Endpoint: [Supply Chains](#)

Using one or more of the following parameters, you can filter the supply chain that is returned by this request:

market_Uuid

The UUID of the market whose supply chain will be returned

types

The entity types whose supply chain will be returned. Choose from:

- BUSINESS_UNIT
- CLOUD_SERVICE
- CONTAINER
- DATABASE
- DATABASE_SERVER
- DATACENTER
- DISK_ARRAY
- PHYSICAL_MACHINE
- STORAGE
- VIRTUAL_MACHINE
- SWITCH
- VIRTUAL_DATACENTER
- CHASSIS
- STORAGE_CONTROLLER
- IO_MODULE
- APPLICATION_SERVER
- VIRTUAL_APPLICATION
- NETWORK
- APPLICATION
- CONTAINER
- CONTAINER_POD
- LOGICAL_POOL
- DPOD
- VPOD
- LOAD_BALANCER

entity_states

Only return entities in the specified states. Choose from:

- ACTIVE:

Entity is actively consuming resources.

- EVACUATED:

Entity is ready to suspend and will not participate in the market, but will not generate a SUSPEND action.

Note: This state replaces the SUSPEND state, and requires additional configuration to enable. Turbonomic does not recommend enabling this state.

- FAILOVER:

This entity is reserved for failover and will not participate in the market.

- IDLE:

Entity is powered off and not actively consuming market resources.

- LAUNCH:

Entity is starting.

- **MAINTENANCE:**
Entity is in maintenance mode.
- **NOT_MONITORED:**
Entity is not currently monitored by Turbonomic.
- **QUEUED:**
Entity is in the process of changing from one state to another.
Note: This state is internal to Turbonomic and will not appear in the UI, but may appear in an API response if the call is executed at the precise moment the entity is changing state.
- **RESOURCE_ALLOCATION:**
Cloud entity is being created.
- **RESOURCE_RELEASE:**
Cloud Entity is being deleted.
- **SUSPEND:**
Entity is suspended or the guest OS is in sleep, standby, or suspended state. The entity is not removed from the environment, but will not be used in market decisions. Based on market conditions, suspended entities can be started, re-adding them to the market.
- **SUSPEND_PENDING:**
Entity is making preparations to suspend, or is the next entity of its type to suspend.
- **TERMINATE_PENDING:**
Entity is in the process of being deleted.
- **UNKNOWN:**
Turbonomic is unable to obtain the current state of the entity.
This occurs when the entity is reported to the hypervisor as having a state of DISCONNECTED, ORPHANED, or INVALID.

environment_type

Only return actions that affect entities in the specified environment type. [CLOUD, HYBRID, ONPREM].

detail_type

The level of detail returned for each item in the returned supply chain. [compact, entity, aspects].

health

Return a small summary of the health of the returned supply chain.

Example: GET https://10.10.10.10/api/v3/markets/Market/supplychains?types=VirtualMachine&entity_states=RESOURCE_ALLOCATION&entity_states=ACTIVE&environment_type=ONPREM&detail_type=aspects&health=true

Response: A SupplychainApiDTO representing the entities meeting your criteria. In the above example, a supply chain including Virtual Machines in the ACTIVE or RESOURCE_ALLOCATION states, in an ONPREM environment, and a healthcheck will be included at the end of the request.

```
{
  "seMap": {
    "VirtualMachine": {
      "depth": -1,
      "entitiesCount": 335,
      "healthSummary": {
        "Major": 6,
        "Minor": 148,
        "Normal": 181
      }
    }
  }
}
```

```

    },
    "stateSummary": {
      "ACTIVE": 335
    },
    "connectedProviderTypes": [
      "PhysicalMachine",
      "Storage",
      "VirtualDataCenter"
    ],
    "connectedConsumerTypes": [
      "Application"
    ],
    "instances": {
      "421edc7a-761d-9a79-9378-7140caecd50f": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/421edc7a-761d-9a79-9378-7140caecd50f?include_aspects=false"
          }
        ],
        "uuid": "421edc7a-761d-9a79-9378-7140caecd50f",
        "displayName": "vm-max-test-netapp",
        "className": "VirtualMachine",
        "priceIndex": 1.0070138,
        "state": "ACTIVE",
        "severity": "Normal",
        "discoveredBy": {
          "uuid": "_8c98wBwnEem2J-ksd11CgA",
          "displayName": "vsphere-dc7.dev.mycorp.com",
          "type": "vCenter"
        },
        "remoteId": "vm-281",
        "aspects": {
          "virtualMachineAspect": {
            "os": "SUSE Linux Enterprise 11 (64-bit)",
            "connectedNetworks": [
              {
                "uuid": "7d6d67a50cfe1979797de159220841a37a55a50c",
                "displayName": "VM network"
              }
            ]
          },
          "numVCPUs": 1,
          "ebsOptimized": false
        },
        "environmentType": "ONPREM"
      },
      ...
    ],
    ...
  }
}

```

Markets Endpoint Tips

Unplaced Entities

When running a plan in Turbonomic, you can add workload or remove infrastructure – if the remaining resources are insufficient for the workload, entities may be "unplaced". Turbonomic provides an array of the unplaced workloads.

Note: An example will be forthcoming.

Finding a Previously Run Plan Market

While the Turbonomic UI makes a plan look like one item, it is not. A plan comprises two parts:

- A scenario, which represents the configuration options for the plan. For more information about plan configuration, see [Scenarios](#).
- The plan market that is created when a scenario is run – this contains the actions, notifications, etc. that make up the state of the market after the plan.

The simplest way to discover a plan market is to execute the GET `https://10.10.10.10/api/v3/markets` and disregard the main market. The main market DTO entry will be similar to the following:

```
{
  "uuid": "777777",
  "displayName": "Market",
  "className": "Market",
  "state": "RUNNING",
  "stateProgress": 100,
  "unplacedEntities": false,
  "environmentType": "HYBRID"
}
```

The other markets that the request returns are plan markets. Plan market DTOs are similar to:

```
{
  "uuid": "214172431889696",
  "displayName": "Add Workload 2",
  "className": "Market",
  "state": "SUCCEEDED",
  "stateProgress": 100,
  "scenario": {
    "uuid": "214172431885856",
    "displayName": "Add Workload 2",
    "owners": [
      {
        "uuid": "2993567556912",
        "showSharedUserSC": false
      }
    ]
  },
  ...
}
```

The outer-most `uuid` and `displayName` parameters are the UUID and display name of plan market. The `state` field shows the results of the plan run, where `SUCCEEDED` means the plan finished successfully, and `FAILED` means the plan did not finish running- usually because it was cancelled by the user.

Within the plan itself, the `scenario` parameter includes information about the scenario used on the market. Note the inner `uuid` and `displayName` are the UUID and display name of the scenario, which you can use to see all markets created using this scenario.

Finally, iterating over the return of the `/markets` call above, and looking at each market and comparing the UUID of the scenario (in this case, 214172431889696), you can see how many times the scenario was run, and also each market containing the results of that run.

Notifications Endpoint

Notifications are system and market messages from your Turbonomic instance.

This endpoint contains references to start and end times for certain operations. For more information, including valid time formats, see [Time in the Turbonomic API](#)

Using the notifications endpoint, you can:

- Get all notifications
- Get a filtered list of notifications
- Get related actions for a specified notification

Notification Categories

Each notification from your Turbonomic instance belongs to a particular category of the following:

- Discovery
- Monitoring
- Control

- Mediation
- Healthcheck
- InterAppliance
- MarketAction
- MarketProblem
- Presentation
- Deploy
- Security

Notifications Requests

Getting Notifications

Gets a list of system and market level notifications. For a list of notifications, the API returns an array of LogEntryApiDTOs. Each LogEntryApiDTO will contain details about the notification, including the time, state, severity, and importance of the notification. To get a single notification, include the UUID of the notification in the request.

This request takes the following parameters:

start_time

The start time for a historic range of notifications.

end_time

The end time for a historic range of notifications.

category

The category of notifications to return. [Discovery, Monitoring, Control, Mediation, Healthcheck, InterAppliance, MarketAction, MarketProblem, Presentation, Deploy, Security]

cursor

When making subsequent calls to retrieve additional results, this is the cursor returned by the last call to this method.

limit

The maximum number of items to return. Must be a positive integer. If not set, the server will provide a default (20).

order_by

The field to order the results by. This value can be any field found in the response.

ascending

Default: true. When false, results will be in descending order.

Examples:

- **All Notifications (no parameters):** GET <https://10.10.10.10/api/v3/notifications>
- **All Notifications (parameters):** GET https://10.10.10.10/api/v3/notifications?start_time=1237056032&end_time=1238056032&limit=100&order_by=name&ascending=true
- **Single Notification:** GET https://10.10.10.10/api/v3/notifications/_5wcf4J5WEeinZ-6Uu4soUw

Response:

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/notifications/_5wcf4J5WEeinZ-6Uu4soUw"
      }
    ]
  }
]
```

```

],
  "uuid": "_5wcf4J5WEeinZ-6Uu4soUw",
  "logActionTime": 1534095671518,
  "targetSE": "Hyper-V:hp-cluster.corp.mycorp.com",
  "category": "Discovery",
  "subCategory": "Validation",
  "description": "Validation of target hp-cluster.corp.mycorp.com failed",
  "shortDescription": "Validation Failed",
  "state": "NOTIFY",
  "severity": "MAJOR",
  "importance": 0
},
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/notifications/_sQ7xUJ5XEeinZ-6Uu4soUw"
    }
  ],
  "uuid": "_sQ7xUJ5XEeinZ-6Uu4soUw",
  "logActionTime": 1534096010470,
  "targetSE": "Hyper-V:hp-cluster.corp.mycorp.com",
  "category": "Discovery",
  "subCategory": "Discovery",
  "description": "Could not get domain for the 'hp-cluster.corp.mycorp.com' target",
  "shortDescription": "Discovery failed",
  "state": "NOTIFY",
  "severity": "MAJOR",
  "importance": 0
},
...
]

```

Policies Endpoint

Policies set business rules to control how Turbonomic analyzes resource allocation, how it displays resource status, and how it recommends or executes actions. There are two kinds of policies:

- Placement Policies

To modify workload placement decisions, Turbonomic divides its market into segments that constrain the valid placement of workloads. Turbonomic discovers placement rules that are defined by the targets in your environment, and you can create your own segments.

- Automation Policies

Turbonomic uses Automation Policies to guide its analysis and resulting actions. These policies can specify Action Automation, Orchestration, and Constraints (operational, utilization, and scaling constraints).

Turbonomic ships with default settings that we believe will give you the best results from our analysis and control. For some scopes of your environment, you might want to change these settings. For example, you might want to change action automation for that scope, or change the utilization constraints.

The hypervisors that you set as targets can include placement policies of their own. Turbonomic imports these placement policies, and you can choose to enable or disable them as you wish. By default, Turbonomic enables imported placement policies.

Using the policies endpoint, you can:

- Get API entry points for policies
- See details about a specific policy

Policies Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble input DTOs, or see the potential values of a particular DTO.

The policies endpoint contains a utility request that shows the entry points for policy-related requests. These can be used to find the UUID and details relating to a specific policy.

Example: GET <https://10.10.10.10/api/v3/policies>

Response: An array of Link objects, where each object contains a URL to get all policies for a specified market, entity, or group.

```
{
  "links": [
    {
      "rel": "Market policies",
      "href": "https://10.10.10.10/api/v3/markets/{uuid}/policies"
    },
    {
      "rel": "Entity policies",
      "href": "https://10.10.10.10/api/v3/entities/{uuid}/policies"
    },
    {
      "rel": "Group policies",
      "href": "https://10.10.10.10/api/v3/groups/{uuid}/policies"
    }
  ],
  "enabled": false
}
```

Policies Requests

Getting the Details of a Specified Policy

The single policy request gets the details of a specified policy, given that policy's UUID. You may use this after getting policies that affect a certain scope, to view details of those policies.

Example: GET <https://10.10.10.10/api/v3/policies/104:domain-c7:10.10.111.111>

Response: A PolicyApiDTO describing details about the policy, including the group information for the provider of the policy.

```
{
  "links": [
    {
      "rel": "self",
      "href": "https://10.10.10.10/api/v3/policies/104:domain-c7:10.10.111.111"
    }
  ],
  "uuid": "104:domain-c7:10.10.111.111",
  "displayName": "GROUP-DRS-LN-rule/Cluster1/10.10.111.111",
  "type": "BIND_TO_GROUP",
  "name": "GROUP-DRS-LN-rule/Cluster1/10.10.111.111",
  "enabled": true,
  "capacity": 1000000000,
  "commodityType": "DrsSegmentationCommodity",
  "consumerGroup": {
    "uuid": "7843e134bab4fb841b9cb7dd98ef04acf1f36f7b",
    "displayName": "Buyers-Group-GROUP-DRS-vmGroup1/Cluster1/10.10.111.111",
    "className": "DiscoveredGroup",
    "groupType": "VirtualMachine",
    "isStatic": true,
    "logicalOperator": "AND"
  },
  "providerGroup": {
    "uuid": "597a35089bfe405291911f3191cf24234d4713d1",
    "displayName": "Sellers-Group-GROUP-DRS-hostGrp1/Cluster1/10.10.111.111",
    "className": "DiscoveredGroup",
    "groupType": "PhysicalMachine",
    "isStatic": true,
    "logicalOperator": "AND"
  }
}
```

Creating a Policy

Policies are created for a specific market- either a plan market, or the real-time market. For more information about policy creation, see the [Markets](#) endpoint.

Reservations Endpoint

Turbonomic uses reservations to save the resources you will need if you want to deploy workloads at a future date. Turbonomic calculates optimal placement for these workloads, and then it reserves whatever resources the different hosts and storage entities will need to support those workloads. For example, you can instruct Turbonomic on 01 January to reserve the resources required for 100 workloads on 07 January.

Using the reservations endpoint of the Turbonomic API, you can:

- Get a list of reservations
- Create a reservation
- Get information about a specific reservation
- Delete a reservation

Reservation States

Reservations will be in one of the following states:

- **FUTURE**

The reservation is set to occur after the current date.

- **INITIAL**

The reservation is being created; occurs at the start time of the reservation.

- **INPROGRESS**

The reservation request has been sent to the market provider(s), and is awaiting results.

- **INVALID**

This error state occurs when a reservation is placed on an unready market (for example, when the market component is restarting) or one of the constraints or templates used in the reservation has been deleted between the creation of the reservation, and the start date.

- **PLACEMENT_FAILED**

The reservation has completed, but there were insufficient resources to place all entites.

- **RESERVED**

The reservation has completed and was able to obtain all needed resources.

- **UNFULFILLED**

The reservation has been added to the database, but has not yet been sent to the market.

Reservations in the Product

From the Workload Placement Page, you can set up reservations to save the resources you will need to deploy workloads at a future date. Turbonomic uses its intelligent workload management to calculate optimal placement for these workloads, and then it reserves whatever resources the different hosts and storage entities will need to support those workloads.

When creating a reservation in the product, you will select the VM template, any constraints (scope, policy, network), then give your reservation a name, virtual machine count, and start and end dates.

Reservations Requests

Creating a Placement Reservation

To create a placement reservation, pass a completed DemandReservationApiInputDTO as input to this request. This DTO will contain information such as the reservation type, the template to use, and the UUIDs of any constraints, such as placement or network policies.

This request takes the following parameters:

apiCallBlock

Default: false. When true, this request will be synchronous, and will not complete until a failure or success response is received.

Example: POST <https://10.10.10.10/api/v3/reservations>

Example inputDTO, to perform a placement check for one instance of a template:

```
{
  "action": "RESERVATION",
  "demandName": "headroomVM",
  "reserveDateTime": "2021-06-29T16:14:04Z",
  "expireDateTime": "2021-06-30T16:14:04Z",
  "parameters": [
    {
      "placementParameters": {
        "count": 1,
        "templateID": "214672816928240"
      }
    }
  ]
}
```

Response: A DemandReservationApiDTO that will include the status of the placement attempt.

```
{
  "uuid": "214769635091168",
  "displayName": "headroomVM",
  "count": 1,
  "status": "UNFULFILLED",
  "reserveDateTime": "2021-06-29T16:14:04Z",
  "expireDateTime": "2021-06-30T16:14:04Z",
  "reservationDeployed": false,
  "demandEntities": [
    {
      "template": {
        "uuid": "214672816928240",
        "displayName": "headroomVM",
        "className": "VirtualMachineProfile"
      },
      "placements": {
      }
    }
  ]
}
```

Deleting a Reservation

Deletes the specified reservation and removes all reserved resources associated with that reservation. This will also remove any pending deployment related to the deleted reservation.

Example: DELETE https://10.10.10.10/api/v3/reservations/_i-FLwdLiEeiuY7KDiLoLWg

Response: A successful deletion request returns a Response Code of 200.

Reservations Endpoint Tips

Customizing a Reservation

When creating a reservation, you should be familiar with placement policies, templates, scope constraints, and network constraints. For information about placement policies, see [Policies](#). For information on templates, see [Templates](#). For information on constraints, see the Turbonomic User Guide.

This request takes the following parameters of the DemandReservationApiInputDTO:

demandName

The display name of the reservation — If you do not specify names for the added workloads, this will be the root name for new VMs which will then be given a numeric suffix.

action

The action type: RESERVATION.

reserveDateTime

The time to calculate the workload placement and create the reservation — This time cannot be earlier than the time that you POST the reservation to the API.

expireDateTime

When to cancel a reservation if Turbonomic cannot place all the workloads by that date — for a RESERVATION action, Turbonomic automatically sets the deploy time to equal this time.

parameters

A DemandReservationParametersDTO, which is itself composed of a PlacementParametersDTO and DeploymentParametersDTO.

In order to pass a completed DemandReservationParametersDTO, you will create a PlacementParametersDTO and DeploymentParametersDTO. The PlacementParametersDTO has the following parameters:

count

The number of workloads in this reservation

templateID

The UUID of the template used for creating the workload required for the placement

entityNames

Name of the placed workload, which will be affixed with a numeric suffix for reservations of more than one workload

constraintIDs

The UUIDs of the scope, group and any policies or network constraints that the reservation will adhere to

geographicRedundancy

When true, geographic redundancy is respected for the reserved workload

For example, the following POST creates a reservation scoped to a specific virtual data center with a UUID of 73365042986774 and network with a UUID of 73365048169751:

```
{
  "action": "RESERVATION",
  "demandName": "DalReservation",
  "reserveDateTime": "2020-03-11T15:44:41Z",
  "expireDateTime": "2020-04-11T15:44:41Z",
  "parameters": [
    {
      "placementParameters": {
        "count": "75",
        "templateID": "214103358655713",
        "constraintIDs": [
          "73365042986774",
          "73365048169751"
        ]
      }
    }
  ]
}
```

```
}
```

Getting Reservation Information

To get a list of current reservations, execute the GET <https://10.10.10.10/api/v3/reservations> request. This returns a list of all active reservations. If you know the UUID of the reservation you want to retrieve, you can pass it to get data for just that reservation.

Each reservation object describes:

- Display name
- Status — can be:
 - IN_PROGRESS — Placement calculation is in progress
 - PLACEMENT_SUCCEEDED — For a new reservation, the environment has sufficient resources to place the workload; if you specified a reserve date, this will be an active reservation
 - PLACEMENT_FAILED — For a newly created reservation, the environment doesn't have resources to place the workload; if you specified a reserve date, this will be an unfulfilled reservation
 - RETRYING — Turbonomic is trying to place the workload of an unfulfilled reservation
- Time the reservation was created, and time it will expire
- A description of the reserved workload
- Statistics for the compute and storage resources the reservation sets aside

For example, this listing shows a successful reservation for one VM:

```
{
  "uuid": "_kWZHIDDmEeePgeXuo0RRbw",
  "displayName": "MyReservation",
  "count": 1,
  "status": "PLACEMENT_SUCCEEDED",
  "reserveDateTime": "Thu May 04 16:27:29 UTC 2017",
  "expireDateTime": "Thu Aug 31 16:27:29 UTC 2017",
  "deployDateTime": "Thu Aug 31 16:27:29 UTC 2017",
  "reserveCount": 1,
  "demandEntities": [
    {
      "uuid": "_kWgb7TDmEeePgeXuo0RRbw",
      "displayName": "MyReservation_C0",
      "className": "VirtualMachine",
      "template": {
        "uuid": "T423f548d-cadc-e525-6df4-1f90724cf696",
        "displayName": "vsphere-dc3.dev.mycorp.com::TMP-SUSE64",
        "className": "VirtualMachineProfile"
      },
      "deploymentProfile": {
        "uuid": "_gHJ0ICXxEeePgeXuo0RRbw",
        "displayName": "DEP-SUSE64",
        "className": "ServiceCatalogItem"
      },
      "placements": {
        "computeResources": [
          {
            "stats": [
              {
                "name": "numOfCpu",
                "value": 1
              },
              {
                "name": "cpuSpeed",
                "value": 2603
              },
              {
                "name": "cpuConsumedFactor",
                "value": 0.5
              },
              {
                "name": "memorySize",
                "value": 2097152
              }
            ]
          }
        ]
      }
    }
  ]
}
```



```

        "name": "memoryConsumedFactor",
        "value": 0.75
      },
      {
        "name": "ioThroughput",
        "value": 0
      },
      {
        "name": "networkThroughput",
        "value": 0
      }
    ],
    "provider": {
      "uuid": "Virtual_ESX_42381da5-12fa-1e82-2f1c-887419380d43",
      "displayName": "hp-esx21.corp.vmturbo.com",
      "className": "PhysicalMachine"
    }
  },
  "storageResources": [
    {
      "stats": [
        {
          "name": "diskSize",
          "value": 18432.363
        },
        {
          "name": "diskIops",
          "value": 0
        }
      ],
      "provider": {
        "uuid": "10545c15-7687ef26",
        "displayName": "QS2:ESXDC3DS1",
        "className": "Storage"
      }
    }
  ]
}

```

Creating a Reservation

To create a reservation, you POST an input DTO that defines the reservation's:

- **action:** The action type: RESERVATION
- **demandName:** The display name of the reservation — If you do not specify names for the added workloads, this will be the root name for new VMs
- **placementParameters:**
 - **constraintIDs:** An array of UUIDs for placement policies that will affect the calculated placement
 - **count:** The number of workloads to place
 - **entityNames:** An array of names for the placed VMs — The array length should equal count
 - **geographicRedundancy:** If true place the workloads on unique hosts, otherwise Turbonomic can place multiple workloads on the same host
 - **templateID:** The UUID of the template that you will use to place this workload — Note that the template must include a reference to the deployment profile that you specify in `deploymentParameters`
- **expireDateTime:** When to cancel a reservation if Turbonomic cannot place all the workloads by that date — for a RESERVATION action, Turbonomic automatically sets the deploy time to equal this time
- **reserveDateTime:** The time to calculate the workload placement and create the reservation — This time cannot be earlier than the time that you POST the reservation to the API

The following listing shows an input DTO that creates a reservation. It will place four workloads, and it gives specific names to each one.

```
{
  "action": "RESERVATION",
  "demandName": "MyReservation",
  "expireDateTime": "2017-10-10T12:38:17+00:00",
  "parameters": [
    {
      "deploymentParameters": {
        "deploymentProfileID": "_c9CJMDDAEeePgeXuo0RRbw"
      },
      "placementParameters": {
        "geographicRedundancy": false,
        "count": 4,
        "entityNames": [
          "foo", "bar", "baz", "bonk"
        ],
        "templateID": "_UKsnkJkSEeCHc0XEhzJExA"
      }
    }
  ],
  "reserveDateTime": "2017-05-04T18:22:12+00:00"
}
```

Async Placement Calculation

When you POST a reservation, Turbonomic runs a plan to calculate the optimal placement of the workloads. Depending on the size of the reservation, this can take a significant amount of time. The API calculates the placement asynchronously. If your script relies on the reservation, you should verify that the reservation has completed before moving on.

When you execute a reservation, the response to your POST shows that the calculation is in progress:

```
{
  "uuid": "_0dPrYTD1EeePgeXuo0RRbw",
  "displayName": "MyReservation",
  "count": 4,
  "status": "IN_PROGRESS",
  "reserveDateTime": "Thu May 04 18:22:12 UTC 2017",
  "expireDateTime": "Tue Oct 10 12:38:17 UTC 2017"
}
```

To examine the placement results, GET the reservation using the UUID that the API gives in the response.

Reserved Instances Endpoint

Turbonomic analysis takes advantage of AWS Reserved Instances and Azure Reserved VM Instances to calculate optimal workload placement and to arrive at the best possible costs for your deployments on the cloud.

Using the reserved instances endpoint of the Turbonomic API, you can:

- Get a single reserved instance or list of reserved instances present in your environment
- Get statistics related to the reserved instances

Reserved Instances Requests

Getting Reserved Instances

For a list of reserved instances, the API returns an array of `ReservedInstanceApiDTOs`. Each `ReservedInstanceApiDTO` will contain the validation status, target type and category, and input field names and values. To get a single reserved instance, include the UUID of the reserved instance in the request.

This request takes the following parameters:

scope

Returns only reserved instances in the specified scope. This can be the scope of a group of entities or target. For example, to see reserved instances for a single AWS target, use that target's UUID here.

Examples:

- All Reserved instances: GET <https://10.10.10.10/api/v3/reservedinstances>
- Reserved Instances for a Specified Scope: GET https://10.10.10.10/api/v3/reservedinstances?scope=_zeCtIMAVEei2-fP3xzx1Fw

Response:

```
[
  {
    "uuid": "aws::eu-west-1::RI::a0643140-85d7-4c5e-a7ba-4ec2fc47bb76",
    "displayName": "i3.large",
    "className": "ReservedInstance",
    "template": {
      "uuid": "aws::VMPROFILE::i3.large",
      "displayName": "i3.large",
      "discovered": false,
      "family": "i3"
    },
    "platform": "LINUX",
    "type": "STANDARD",
    "location": {
      "uuid": "aws::eu-west-1::DC::eu-west-1",
      "displayName": "aws-EU (Ireland)"
    },
    "accountId": "19265476245",
    "targetId": "_zeCtIMAVEei2-fP3xzx1Fw",
    "masterAccountId": "194356375",
    "term": {
      "units": "Year",
      "values": {
        "max": 1,
        "min": 1,
        "avg": 1,
        "total": 1
      },
      "value": 1
    },
    "payment": "PARTIAL_UPFRONT",
    "onDemandPrice": {
      "units": "$/h",
      "values": {
        "max": 0.172,
        "min": 0.172,
        "avg": 0.172,
        "total": 0.172
      },
      "value": 0.172
    },
    "costPrice": {
      "units": "$/h",
      "values": {
        "max": 0.11193608,
        "min": 0.11193608,
        "avg": 0.11193608,
        "total": 0.11193608
      },
      "value": 0.11193608
    },
    "coupons": {
      "capacity": {
        "max": 16,
        "min": 16,
        "avg": 16
      },
      "units": "RICoupon",
      "values": {
        "max": 0,
        "min": 0,
        "avg": 0,
        "total": 0
      },
      "value": 0
    }
  },
]
```

```

    "totalCoupons": 0,
    "expDate": "Sat Apr 06 19:11:19 EDT 2019",
    "instanceCount": 1,
    "tenancy": "DEFAULT",
    "upFrontCost": 490,
    "actualHourlyCost": 0.05600000017285347,
    "effectiveHourlyCost": 0.11193607478789543
  },
  ...
]

```

Getting Entities Covered by Reserved Instances

Given the UUID of a reserved instance, the API returns a list of entities covered by the reserved instance.

This request takes the following parameters:

reservedInstance_Uuid

The UUID of the reserved instance.

Example: GET <https://10.10.10.10/api/v3/reservedinstances/1234/coveredEntities>

Response: An array of BaseApiDTOs describing the entities covered by the specified RI.

```

[
  {
    "uuid": "73943736161360",
    "displayName": "pyaus",
    "className": "VirtualMachine"
  },
  {
    "uuid": "73812178348464",
    "displayName": "ptaub807disabled",
    "className": "VirtualMachine"
  },
  {
    "uuid": "73746051159552",
    "displayName": "pymm",
    "className": "VirtualMachine"
  }
]

```

Scenarios Endpoint

To run a plan scenario, Turbonomic creates a snapshot copy of your real-time market and modifies that snapshot according to the scenario. It then uses the Economic Scheduling Engine to perform analysis on that plan market. A scenario can modify the snapshot market by changing the workload, adding or removing hardware resources, or changing or eliminating constraints such as cluster boundaries or placement policies.

As it runs a plan, Turbonomic continuously analyzes the plan market until it arrives at the optimal conditions that market can achieve. When it reaches that point, the Economic Scheduling Engine cannot find better prices for any of the resources demanded by the workload — the plan stops running, and it displays the results as the plan's desired state.

The display includes the resulting workload distribution across hosts and datastores, as well as a list of actions the plan executed to achieve the desired result.

For example, assume a scenario that adds virtual machines to a cluster. To run the plan, Turbonomic takes a snapshot of the current market, and adds the VMs to the specified cluster. Turbonomic then runs analysis on the plan market, where each entity in the supply chain shops for the resources it needs, always looking for a better price — looking for those resources from less-utilized suppliers. This analysis continues until all the resources are provided at the best possible price.

The results might show that you can add more workload to your environment, even if you reduce compute resources by suspending physical machines. The recommended actions would then indicate which hosts you can take offline, and how to distribute your virtual machines among the remaining hosts.

The settings you make in a scenario correspond to the plan settings you can make in the user interface. These include:

- Plan scope
- Changes to workload (adding, removing, or replacing VMs or containers)
- Changes to supply (adding, removing, replacing PMs or storage)
- Enable/disable placement policies and other constraints
- Changes to action modes
- Enable/disable provisioning of supply
- Enable/disable resizing of workloads

Using the scenarios endpoint of the Turbonomic API, you can:

- Get a list of scenarios on your instance
- Create a scenario
- Get a list of markets that are connected to a particular scenario

Scenarios Requests

Getting Scenarios

The API returns a `ScenarioApiDTO` including the following fields when you execute a `GET /scenarios` request:

- `uuid`
The unique identifier for this scenario.
- `displayName`
By default, Turbonomic creates a display name that matches the scenario type. You may rename the scenario after creation using a PUT request.
- `owners`
An array of user accounts that can use the scenario. Currently, this is always the user that created the scenario.
- `type`
The type of scenario. When a user creates a scenario in the GUI, this matches the given type that user chooses from the Plan Wizard.
- `scope`
An array of scope objects to specify the scope of the plan.
- `projectionDays`
An array of days to specify how far into the future to project the plan. For example, a value of `[30, 60, 120]` would return projections after one, two, and four months, respectively.
- `topologyChanges`
An array of additions or deletions to the set of entities in the plan scope.
- `loadChanges`
An array of changes to the utilization percentage for different groups of entities within the plan scope.
- `configChanges`
An array of configuration changes for different groups of entities within the plan scope.
- `changes` - DEPRECATED
An array of scenario settings that make changes to the market before running the plan.

Example: GET https://10.10.10.10/api/v3/scenarios?show_all=false

Response:

```
{
  "uuid": "214704587455872",
  "displayName": "Migrate to Public Cloud 1_CLOUD_MIGRATION__CONSUMPTION",
  "type": "CLOUD_MIGRATION",
  "scope": [
    {
      "uuid": "73935388327649",
      "displayName": "aws-EU (Frankfurt)",
      "className": "Region"
    }
  ],
  "projectionDays": [
    0
  ],
  "topologyChanges": {
    "migrateList": [
      {
        "projectionDay": 0,
        "source": {
          "uuid": "285041726554576",
          "displayName": "Unknown"
        },
        "destination": {
          "uuid": "73935388327649",
          "displayName": "aws-EU (Frankfurt)",
          "className": "Region",
          "state": "ACTIVE",
          "severity": "Minor",
          "discoveredBy": {
            "uuid": "73935444966640",
            "displayName": "testmachine",
            "category": "Public Cloud",
            "type": "AWS",
            "readonly": false
          },
          "severityBreakdown": {
            "MINOR": 1
          },
          "numRelatedVMs": 2,
          "environmentType": "CLOUD",
          "vendorIds": {
            "vmturboamp": "aws::eu-central-1::DC::eu-central-1"
          }
        },
        "sources": [
          {
            "uuid": "285041726554576",
            "displayName": "Unknown"
          }
        ],
        "destinations": [
          {
            "uuid": "73935388327649",
            "displayName": "aws-EU (Frankfurt)",
            "className": "Region",
            "state": "ACTIVE",
            "severity": "Minor",
            "discoveredBy": {
              "uuid": "73935444966640",
              "displayName": "testmachine",
              "category": "Public Cloud",
              "type": "AWS",
              "readonly": false
            },
            "severityBreakdown": {
              "MINOR": 1
            },
            "numRelatedVMs": 2,
            "environmentType": "CLOUD",
            "vendorIds": {
              "vmturboamp": "aws::eu-central-1::DC::eu-central-1"
            }
          }
        ],
        "destinationEntityType": "VirtualMachine",
        "removeNonMigratingWorkloads": true
      }
    ]
  }
}
```

```

    ],
    "loadChanges": {
      "utilizationList": [],
      "maxUtilizationList": []
    },
    "configChanges": {
      "addPolicyList": [],
      "removePolicyList": [],
      "automationSettingList": [],
      "removeConstraintList": [],
      "riSettingList": [
        {
          "uuid": "ri.aws.preferredOfferingClass",
          "displayName": "Type",
          "value": "STANDARD",
          "valueObjectType": "String"
        },
        {
          "uuid": "ri.aws.preferredPaymentOption",
          "displayName": "Payment",
          "value": "ALL_UPFRONT",
          "valueObjectType": "String"
        },
        {
          "uuid": "ri.aws.preferredTerm",
          "displayName": "Term",
          "value": "YEARS_1",
          "valueObjectType": "String"
        }
      ],
      "osMigrationSettingList": [
        {
          "uuid": "linuxTargetOs",
          "displayName": "linuxTargetOs",
          "value": "LINUX",
          "valueObjectType": "String"
        },
        {
          "uuid": "linuxByol",
          "displayName": "linuxByol",
          "value": "false",
          "valueObjectType": "String"
        },
        {
          "uuid": "rhelTargetOs",
          "displayName": "rhelTargetOs",
          "value": "RHEL",
          "valueObjectType": "String"
        },
        {
          "uuid": "rhelByol",
          "displayName": "rhelByol",
          "value": "false",
          "valueObjectType": "String"
        },
        {
          "uuid": "slesTargetOs",
          "displayName": "slesTargetOs",
          "value": "SLES",
          "valueObjectType": "String"
        },
        {
          "uuid": "slesByol",
          "displayName": "slesByol",
          "value": "false",
          "valueObjectType": "String"
        },
        {
          "uuid": "windowsTargetOs",
          "displayName": "windowsTargetOs",
          "value": "WINDOWS",
          "valueObjectType": "String"
        },
        {
          "uuid": "windowsByol",
          "displayName": "windowsByol",
          "value": "false",
          "valueObjectType": "String"
        },
        {
          "uuid": "selectedMigrationProfileOption",

```

```

        "displayName": "selectedMigrationProfileOption",
        "value": "MATCH_SOURCE_TO_TARGET_OS",
        "valueObjectType": "String"
    },
    {
        "uuid": "matchToSource",
        "displayName": "matchToSource",
        "value": "true",
        "valueObjectType": "String"
    }
],
"includedCoupons": {
    "includedCouponOidsList": [],
    "iswhiteList": true
},
"subscription": {
    "uuid": "73935382668544",
    "displayName": "EngineeringSample",
    "className": "BusinessAccount",
    "accountId": "323871187550",
    "master": false,
    "cloudType": "AWS",
    "riSupported": false,
    "hasRelatedTarget": false
}
}
}

```

Creating a Scenario

In order to create a scenario, see the “Scenario DTO Breakdown” on page 878. For examples of complete ScenarioApiDTOs, see “Scenario Configuration Examples” on page 888.

Deleting a Scenario

Deletes the specified scenario. Note that this does not delete plan markets you create using that scenario.

Example: DELETE https://10.10.10.10/api/v3/scenarios/__xwWYAE3EeiNKPbzHdETIA

Response: A successful deletion request returns a Response Code of 200.

Scenario DTO Breakdown

Scenario DTO Overview

A scenario DTO assembles configuration settings that you use to set up and run a plan. To run a plan, you will POST the scenario to a market. For most plans, this will be the real-time market. In the case of a plan-over-plan, this will be the market created from the first scenario.

Turbonomic will then run a plan based on the combination of the scenario and the market state.

These configuration settings fall into one of several groups:

Configuration Changes (ConfigChangesApiDTO)

Adding and removing placement policies, removing constraints, and providing automation settings, OS migration settings, reserved instance settings, and associated business units.

Load Changes (LoadChangesApiDTO)

Modifications to the current and max utilization values, and peak baseline values.

Time-Based Topology Changes (TimeBasedTopologyChangesApiDTO)

Settings to include reserved VMs and periodically add historical workload to the environment.

Topology Changes (TopologyChangesApiDTO)

Settings to add, remove, replace, and migrate workload, or to specify the clusters for an Alleviate Pressure plan.

DTO Configuration Changes

The scenario configuration changes, located in the `configChanges` parameter of the `ScenarioApiDTO`, enable you to perform the following tasks:

addPolicyList

Add a placement policy to the market generated for this plan.

automationSettingList

Change one of the available automation plan settings: VM Resize, Host Provision/Suspend, and Storage Provision/Suspend.

osMigrationSettingList

For a Migrate to Cloud plan, this parameter will contain the source and destination OS platforms, and their BYOL (Bring Your Own License) status.

removeConstraintList

Remove a constraint from the market generated for this plan.

removePolicyList

Remove a placement policy from the market generated for this plan.

riSettingList

Add information about your reserved cloud instances.

subscription

Associate a business unit to the plan.

Adding and Removing Placement Policies

Referenced Endpoint: [Policies](#)

When running plans, you might want to see what your environment would look like with or without certain policies enabled, or with a new policy present. You can see the effects of these changes by passing the UUIDs of current policies, or a `PolicyApiDTO` for a new policy.

Example input (Current Policies):

```
"addPolicyList": [
  {
    "uuid": " VnNS0CsqEemvEL3szcXU1Q",
    "uuid": "522a3317-39f5-1a97-3b53-d725927a6ae8",
    "uuid": "52672058-a93b-d0a9-bbd9-5acd33f27882"
  }
]
```

Example input (New Policy):

```
"addPolicyList": [
  {
    "capacity": null,
    "consumerGroup": {
      "uuid": "8c17d8e79c3db85ed5d3868de622cb89187849ce",
      "displayName": "PMS_Beta DC6\\Cluster-2",
      "className": "Group",
      "groupType": "PhysicalMachine",
      "isStatic": true,
      "logicalOperator": "AND"
    },
    "enabled": true,
    "mergeGroups": null,
    "mergeType": null,
    "name": "DalTestPolMerge",
    "displayName": "DalTestPolMerge",
    "providerGroup": {
      "uuid": "91ff08749fd278925d73b61b0f0f69d79c99fc3a",
      "displayName": "PMS_Beta DC6\\Cluster-1",
      "className": "Group",
      "groupType": "PhysicalMachine",
      "isStatic": true,
      "logicalOperator": "AND"
    },
    "type": "MERGE",
  }
]
```

```

    "uuid": ""
  }
]

```

Setting Plan Automation Settings

Use the plan automation settings to see the effect of your scenario if VM resizes, Host Provisioning / Suspension, and Storage Provisioning / Suspension are enabled or disabled.

Example Input:

```

"automationSettingList":[
{
  "uuid":"resize",
  "displayName":"Resize for VMS disabled",
  "value":"false",
  "entityType":"VirtualMachine"
},
{
  "uuid":"provisionPM",
  "displayName":"Provision for PHYSICALMACHINES disabled",
  "value":"false",
  "entityType":"PhysicalMachine"
},
{
  "uuid":"suspendPM",
  "displayName":"Suspend for PHYSICALMACHINES disabled",
  "value":"false",
  "entityType":"PhysicalMachine"
},
{
  "uuid":"provisionDS",
  "displayName":"Provision for STS disabled",
  "value":"false",
  "entityType":"Storage"
},
{
  "uuid":"suspendDS",
  "displayName":"Suspend for STS enabled",
  "value":"true",
  "entityType":"Storage"
}
]

```

Additionally, you can use these settings to adjust operational constraints, such as provisioned values for CPU and MEM:

Example Input:

```

"automationSettingList":[
{
  "uuid":"capacity_MemProvisioned",
  "displayName":"Mem Overprovisioned Percentage",
  "value":"9876.0",
  "defaultValue":"1000.0",
  "categories":[
    "utilizationThresholds"
  ],
  "valueType":"NUMERIC",
  "min":1,
  "max":1000000,
  "entityType":"PhysicalMachine",
  "sourceGroupName":"Global"
}
]

```

Providing Cloud Reserved Instance Information

Turbonomic enables you to upload RI pricing information specific to the scenario.

Example Input:

```

"riSettingList": [
{

```

```

    "uuid": "preferredTerm",
    "displayName": "Term",
    "value": "YEARS_1",
    "entityType": "YEARS_1"
  },
  {
    "uuid": "preferredPaymentOption",
    "displayName": "Payment",
    "value": "PARTIAL_UPFRONT",
    "entityType": "PARTIAL_UPFRONT"
  },
  {
    "uuid": "preferredOfferingClass",
    "displayName": "Type",
    "value": "STANDARD",
    "entityType": "STANDARD"
  },
  {
    "uuid": "preferredCoverage",
    "displayName": "Coverage",
    "value": "80",
    "entityType": "80"
  },
  {
    "uuid": "riCoverageOverride",
    "displayName": "RI Coverage Override",
    "value": "false",
    "entityType": "false"
  }
]

```

Removing Constraints

Referenced Endpoint: [Entities](#)

When running plans, you might want to see what your environment would look like with or without certain constraints. For example, if a group of virtual machines was allowed to move to any cluster of your environment.

In order to remove a constraint, you must know its UUID. To get a list of constraints for this entity, execute the `/entities/ENTITY_UUID/constraints` request for the entity whose constraint you wish to remove.

```

"removeConstraintList": [
  {
    "constraintType": "ClusterCommodity",
    "projectionDay": 0,
    "target": {
      "uuid": "a6d365f4fbf03fb9a2e8cdb29e38045e31cee41b",
      "displayName": "Beta_DC6_vm",
      "className": "VirtualMachine"
    }
  }
]

```

Setting OS Migration Settings for a Migrate to Cloud Plan

When performing a Migrate to Cloud plan, you might want to use custom OS migration settings. You can specify both the OS mapping, and the BYOL (bring your own license) status of each OS in the mapping.

Example Input:

```

"osMigrationSettingList": [
  {
    "uuid": "linuxTargetOs",
    "displayName": "linuxTargetOs",
    "value": "LINUX"
  },
  {
    "uuid": "linuxByol",
    "displayName": "linuxByol",
    "value": "true"
  }
]

```

```

    "uuid": "rhelTarget0s",
    "displayName": "rhelTarget0s",
    "value": "RHEL"
  },
  {
    "uuid": "rhelByol",
    "displayName": "rhelByol",
    "value": "false"
  },
  {
    "uuid": "slesTarget0s",
    "displayName": "slesTarget0s",
    "value": "WINDOWS"
  },
  {
    "uuid": "slesByol",
    "displayName": "slesByol",
    "value": "true"
  },
  {
    "uuid": "windowsTarget0s",
    "displayName": "windowsTarget0s",
    "value": "WINDOWS"
  },
  {
    "uuid": "windowsByol",
    "displayName": "windowsByol",
    "value": "true"
  },
  {
    "uuid": "showMatchSourceToTarget0sOption",
    "displayName": "showMatchSourceToTarget0sOption",
    "value": "true"
  },
  {
    "uuid": "showByolOption",
    "displayName": "showByolOption",
    "value": "false"
  },
  {
    "uuid": "showCustomOsOption",
    "displayName": "showCustomOsOption",
    "value": "true"
  },
  {
    "uuid": "matchToSource",
    "displayName": "matchToSource",
    "value": "false"
  },
  {
    "uuid": "selectedMigrationProfileOption",
    "displayName": "selectedMigrationProfileOption",
    "value": "CUSTOM_OS"
  }
]

```

Scenario DTO Load Changes

The scenario load changes, located in the `loadChanges` parameter of the `ScenarioApiDTO`, make workload utilization changes that enable you to change the following values:

baselineDate

If your plan should be run using historical data, the date of the data to be used.

maxUtilizationList

Changes the max utilization values for a group of entities in your plan.

peakBaselineList

Changes the peak baseline values for a group of entities in your plan.

utilizationList

Changes the utilization values for a group of entities in your plan.

Changing the Baseline Date

Example input:

```
"baselineDate": 1552622400000
```

Changing the Utilization For a Group of Entities**Example input:**

```
"utilizationList": [
  {
    "percentage": -12,
    "projectionDay": 0,
    "target": {
      "displayName": "Global Environment",
      "uuid": "Market"
    }
  }
]
```

Changing the Maximum Utilization For a Group of Entities**Example input:**

```
"maxUtilizationList": [
  {
    "maxPercentage": 82,
    "projectionDay": 0,
    "target": {
      "displayName": "All On-prem Hosts",
      "className": "Group",
      "uuid": "_PE0v-YEUEee_hYfzgV9uYg"
    }
  },
  {
    "maxPercentage": 85,
    "projectionDay": 0,
    "target": {
      "displayName": "ACM_datastore",
      "className": "Group",
      "uuid": "c31a6f99f4409700115fc61fca71e5449ad68700"
    }
  },
  {
    "maxPercentage": 77,
    "projectionDay": 0,
    "target": {
      "displayName": "Beta DC6_datastore",
      "className": "Group",
      "uuid": "5544c35ed3d7fc0d33879d3457c219d7e40fc176"
    }
  }
]
```

Scenario DTO Time-Based Topology Changes

The scenario time-based topology changes, located in the `timebasedTopologyChanges` parameter of the `ScenarioApiDTO`, make time-dependent topology changes to your scenario, such as:

addHistoryVMs

If `true`, Turbonomic will add additional workload to your scenario each month equal to the workload added to the real-time market in the previous month.

includeReservation

If `true`, Turbonomic will take current reservations and reflect their resource utilization when the scenario runs.

Adding Historical VM Usage and/or Including VM Reservations

Example input:

```

"timebasedTopologyChanges": [
  {
    "addHistoryVMs": "true",
    "includeReservation": "true"
  }
]

```

Scenario DTO Topology Changes

The scenario topology changes, located in the topologyChanges parameter of the ScenarioApiDTO, make topology changes to your scenario, such as:

addList

A list of entities to add to your environment as part of plan configuration.

migrateList

A list of entities to move from one set of providers to another as part of plan configuration.

relievePressureList

In a Relieve Pressure plan, the source and target clusters.

removeList

A list of entities to be removed from your environment as part of plan configuration.

replaceList

A list of entities and the templates to replace them in your environment as part of plan configuration.

Adding Workload

Adding workload to a scenario simulates the effect of increased VM or container density in your environment. You can add multiple copies of VM groups or individual VMs.

Example input:

```

"addList": [
  {
    "count": 3,
    "projectionDays": [
      0
    ],
    "target": {
      "uuid": "421dd4ce-a4c1-231a-71e7-64fbf598bc65",
      "displayName": "AJ_Test",
      "className": "VirtualMachine"
    }
  },
  {
    "count": 10,
    "projectionDays": [
      0
    ],
    "target": {
      "uuid": "421e503d-d0c0-75f9-8cce-79421924a90d",
      "displayName": "olg_test",
      "className": "VirtualMachine"
    }
  },
  {
    "count": 5,
    "projectionDays": [
      0
    ],
    "target": {
      "uuid": "420f1840-297f-5a39-9543-b72046b9126f",
      "displayName": "opensuse_with_stress_template",
      "className": "VirtualMachine"
    }
  },
  {
    "count": 1,
    "projectionDays": [
      0
    ],
    "target": {
      "uuid": "420f1840-297f-5a39-9543-b72046b9126f",
      "displayName": "opensuse_with_stress_template",
      "className": "VirtualMachine"
    }
  }
]

```

```

    ],
    "target": {
      "uuid": "53523c9a4c5d67962a96f90f59456b0c3e72aca0",
      "displayName": "Development67_vm",
      "className": "VirtualMachine"
    }
  }
]

```

Migrating Workload to the Cloud

Turbonomic includes a special plan to simulate migration of on-premise workload to the cloud, or migration of workloads from one cloud to another. This plan focuses on optimizing your costs on the cloud by choosing the best templates (most adequate compute resources) and regions to host your workloads. If analysis discovers on-premise workloads that are good candidates for Reserved Instances (RIs), then it recommends migrating to those templates, and can even recommend purchasing more RI capacity. For each group of virtual machines to be migrated (source), you must provide a destination.

Example input:

```

"migratelist": [
  {
    "projectionDay": 0,
    "source": {
      "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
      "displayName": "ACM_vm",
      "className": "VirtualMachine",
      "severity": "Major"
    },
    "destination": {
      "uuid": "GROUP-PMsByTargetType_Azure",
      "displayName": "PMs_Azure",
      "className": "PhysicalMachine"
    }
  },
  {
    "projectionDay": 0,
    "source": {
      "uuid": "fe23c8642efc5ad2ed4fa1cc502dfb179b8dc9d2",
      "displayName": "Development DC1_vm",
      "className": "VirtualMachine",
      "severity": "Major"
    },
    "destination": {
      "uuid": "GROUP-PMsByTargetType_Azure",
      "displayName": "PMs_Azure",
      "className": "PhysicalMachine"
    }
  },
  {
    "projectionDay": 0,
    "source": {
      "uuid": "f0e26cb417d8143173270b7f01c7213e027cd9e5",
      "displayName": "Development DC7_vm",
      "className": "VirtualMachine",
      "severity": "Major"
    },
    "destination": {
      "uuid": "GROUP-PMsByTargetType_Azure",
      "displayName": "PMs_Azure",
      "className": "PhysicalMachine"
    }
  }
]

```

Relieve Pressure

Including this parameter creates an Alleviate Pressure plan to find out how to migrate workloads from a stressed or hot cluster over to a cluster with more headroom.

Example input:

```

"relievePressureList": [
  {

```

```

    "projectionDay": 0,
    "sources": [
      {
        "uuid": "11c63ebd77647e7b9c9fb85dd2d4c77464cbeac2",
        "displayName": "DC13\\DC13-Cluster",
        "className": "Cluster"
      }
    ],
    "destinations": [
      {
        "uuid": "57a4026a69ba4b46ebc430cb62d5c55eeea00695",
        "displayName": "DC13\\Physical Hosts_Cluster2 - Intel",
        "className": "Cluster"
      }
    ]
  }
]

```

Removing Workload

Removing workload in a scenario configuration simulates the effect of decreased VM or container density in your environment. You can remove VM groups or individual VMs.

Example input:

```

"removeList": [
  {
    "projectionDay": 0,
    "target": {
      "uuid": "5E4F6056-8783-45BC-9070-35CF09457E98",
      "displayName": "AH-TestHyperV-VM001",
      "className": "VirtualMachine"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "421d62c2-964a-0f4f-32cb-ec4cec9e26db",
      "displayName": "Anshuman_MidServer",
      "className": "VirtualMachine"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "421e048b-f66b-539c-f743-7dcc7b40943b",
      "displayName": "Gilad_XL_Storage_Testing - Pure-1",
      "className": "VirtualMachine"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "421e9199-7159-04f2-29fc-6a501f44d1be",
      "displayName": "Gilad_XL_Storage_Testing - Pure-2",
      "className": "VirtualMachine"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "421d9ec6-ab97-84d0-4b12-2db88ae43e2a",
      "displayName": "MS-SQLServer-3",
      "className": "VirtualMachine"
    }
  }
]

```

Replacing Workload

When you replace workload, you select one or more VMs or containers that you want to change (target), and then you select a template to use in their place.

Example input:

```
"replaceList": [
  {
    "projectionDay": 0,
    "target": {
      "uuid": "421ef003-e152-5a25-6e03-19698340cd01",
      "displayName": "centos_imp_7",
      "className": "VirtualMachine",
      "severity": "Minor"
    },
    "template": {
      "uuid": "_wIBz8Jj4EeC6nYMiQT1jqA",
      "displayName": "Microsoft_SQL2008-small",
      "className": "VirtualMachineProfile"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "42001807-bc8f-b144-8ff6-eb0d0d32cc7a",
      "displayName": "cheuk-OpsMgr-172.113",
      "className": "VirtualMachine",
      "severity": "Minor"
    },
    "template": {
      "uuid": "_wIBz8Jj4EeC6nYMiQT1jqA",
      "displayName": "Microsoft_SQL2008-small",
      "className": "VirtualMachineProfile"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "4211806a-65f2-8be1-1015-a4abe1a2ab6f",
      "displayName": "dim-dc13amd-6.2.7_01",
      "className": "VirtualMachine",
      "severity": "Minor"
    },
    "template": {
      "uuid": "_wIBz8Jj4EeC6nYMiQT1jqA",
      "displayName": "Microsoft_SQL2008-small",
      "className": "VirtualMachineProfile"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "42008beb-264e-b0f6-2295-f3443e4ce7d6",
      "displayName": "enOpenShiftInfra1",
      "className": "VirtualMachine",
      "severity": "Minor"
    },
    "template": {
      "uuid": "_wIBz8Jj4EeC6nYMiQT1jqA",
      "displayName": "Microsoft_SQL2008-small",
      "className": "VirtualMachineProfile"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "420036f6-27c3-0252-439d-e23bcff63d02",
      "displayName": "enOpenShiftInfra2",
      "className": "VirtualMachine",
      "severity": "Minor"
    },
    "template": {
      "uuid": "_wIBz8Jj4EeC6nYMiQT1jqA",
      "displayName": "Microsoft_SQL2008-small",
      "className": "VirtualMachineProfile"
    }
  },
  {
    "projectionDay": 0,
    "target": {
      "uuid": "4200ba09-71eb-3084-026e-1770c23abaa4",
      "displayName": "enOpenshiftDNS",
      "className": "VirtualMachine",
      "severity": "Minor"
    }
  }
],
```

```

    "template": {
      "uuid": "_wIBz8Jj4EeC6nYMiQT1jqA",
      "displayName": "Microsoft_SQL2008-small",
      "className": "VirtualMachineProfile"
    }
  }
]

```

Scenario Configuration Examples

Basic Scenario POSTs and Responses

Most scenarios consist of multiple configuration changes. However, the UI provides several starting points for custom configuration based on plan type.

Turbonomic provides the same starting point in the API via the /scenarios endpoint and the following list of POST calls and server responses:

The following examples are simplified in order to accomplish a single goal. There are many other options you might choose in conjunction with those in the following examples.

Add Workload

POST:

```

{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "Add Workload- Basic",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [
    0
  ],
  "scope": [
    {
      "uuid": "Market",
      "displayName": "Global Environment",
      "className": "Market"
    }
  ],
  "topologyChanges": {
    "addList": [
      {
        "count": 50,
        "projectionDays": [
          0
        ],
        "target": {
          "uuid": "421dd4ce-a4c1-231a-71e7-64fbf598bc65",
          "displayName": "AJ_Test",
          "className": "VirtualMachine"
        }
      }
    ],
    "migrateList": [],
    "removeList": [],
    "replaceList": [],
    "relievePressureList": []
  },
  "type": "ADD_WORKLOAD"
}

```

Response:

```
{
  "uuid": "2502057162928",
  "displayName": "Add Workload- Basic",
  "owners": [
    {
      "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
      "username": "administrator",
      "showSharedUserSC": false
    }
  ],
  "type": "ADD_WORKLOAD",
  "scope": [
    {
      "uuid": "_0x30YUg1Ed-gHc4L513y0A",
      "displayName": "Market",
      "className": "Market"
    }
  ],
  "projectionDays": [
    0
  ],
  "topologyChanges": {
    "addList": [
      {
        "projectionDays": [
          0
        ],
        "target": {
          "uuid": "421dd4ce-a4c1-231a-71e7-64fbf598bc65",
          "displayName": "AJ_Test",
          "className": "VirtualMachine"
        },
        "count": 50
      }
    ]
  },
  "loadChanges": {},
  "configChanges": {},
  "changes": [
    {
      "index": 1,
      "type": "SCOPE",
      "scope": [
        {
          "uuid": "_0x30YUg1Ed-gHc4L513y0A",
          "displayName": "Market",
          "className": "Market"
        }
      ]
    },
    {
      "index": 2,
      "type": "PROJECTION_PERIODS",
      "projectionDays": [
        0
      ]
    },
    {
      "index": 3,
      "type": "ADDED",
      "description": "50 AJ_Test",
      "targets": [
        {
          "uuid": "421dd4ce-a4c1-231a-71e7-64fbf598bc65",
          "displayName": "AJ_Test",
          "className": "VirtualMachine",
          "severity": "Major"
        }
      ],
      "value": "50",
      "projectionDays": [
        0
      ]
    }
  ],
  "timebasedTopologyChanges": {}
}
```

Decommission Hosts

POST:

```
{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [
      {
        "uuid": "provisionPM",
        "displayName": "PROVISION for PHYSICALMACHINES disabled",
        "value": "false",
        "entityType": "PhysicalMachine"
      }
    ],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "Decommission Hosts- Basic",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [
    0
  ],
  "scope": [
    {
      "uuid": "Market",
      "displayName": "Global Environment",
      "className": "Market"
    }
  ],
  "topologyChanges": {
    "addList": [],
    "migratelList": [],
    "removeList": [
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-0042-5A10-804A-B1C04F384331",
          "displayName": "dell-pe1944.corp.vmturbo.com",
          "className": "PhysicalMachine"
        }
      },
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-004A-3610-8057-C8C04F464331",
          "displayName": "dell-pe1953.corp.vmturbo.com",
          "className": "PhysicalMachine"
        }
      },
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-0059-4D10-8030-B3C04F464331",
          "displayName": "dell-pe1954.corp.vmturbo.com",
          "className": "PhysicalMachine"
        }
      }
    ],
    "replaceList": [],
    "relievePressureList": []
  },
  "type": "DECOMMISSION_HOST"
}
```

Response:

```
{
  "uuid": "2502061312640",
  "displayName": "Decommission Hosts- Basic",
  "owners": [
    {

```

```

        "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
        "username": "administrator",
        "showSharedUserSC": false
    }
},
"type": "DECOMMISSION_HOST",
"scope": [
    {
        "uuid": "_0x30YUg1Ed-gHc4L513y0A",
        "displayName": "Market",
        "className": "Market"
    }
],
"projectionDays": [
    0
],
"topologyChanges": {
    "removeList": [
        {
            "projectionDay": 0,
            "target": {
                "uuid": "4C4C4544-0042-5A10-804A-B1C04F384331",
                "displayName": "dell-pe1944.corp.vmturbo.com",
                "className": "PhysicalMachine"
            }
        },
        {
            "projectionDay": 0,
            "target": {
                "uuid": "4C4C4544-004A-3610-8057-C8C04F464331",
                "displayName": "dell-pe1953.corp.vmturbo.com",
                "className": "PhysicalMachine"
            }
        },
        {
            "projectionDay": 0,
            "target": {
                "uuid": "4C4C4544-0059-4D10-8030-B3C04F464331",
                "displayName": "dell-pe1954.corp.vmturbo.com",
                "className": "PhysicalMachine"
            }
        }
    ]
},
"loadChanges": {},
"configChanges": {
    "automationSettingList": [
        {
            "uuid": "provisionPM",
            "displayName": "Provision",
            "value": "false",
            "defaultValue": "RECOMMEND",
            "valueType": "STRING",
            "options": [
                {
                    "label": "Disabled",
                    "value": "DISABLED"
                },
                {
                    "label": "Recommend",
                    "value": "RECOMMEND"
                },
                {
                    "label": "Manual",
                    "value": "MANUAL"
                },
                {
                    "label": "Automated",
                    "value": "AUTOMATIC"
                }
            ],
            "entityType": "PhysicalMachine",
            "sourceGroupName": "Global"
        }
    ]
},
"changes": [
    {
        "index": 1,
        "type": "SCOPE",
        "scope": [
            {

```

```

        "uuid": "_0x30YUg1Ed-gHc4L513y0A",
        "displayName": "Market",
        "className": "Market"
    }
}
},
{
    "index": 2,
    "type": "PROJECTION_PERIODS",
    "projectionDays": [
        0
    ]
},
{
    "index": 3,
    "type": "REMOVED",
    "description": "dell-pe1944.corp.vmturbo.com",
    "targets": [
        {
            "uuid": "4C4C4544-0042-5A10-804A-B1C04F384331",
            "displayName": "dell-pe1944.corp.vmturbo.com",
            "className": "PhysicalMachine",
            "severity": "Critical"
        }
    ],
    "value": "1",
    "projectionDays": [
        0
    ]
},
{
    "index": 4,
    "type": "REMOVED",
    "description": "dell-pe1953.corp.vmturbo.com",
    "targets": [
        {
            "uuid": "4C4C4544-004A-3610-8057-C8C04F464331",
            "displayName": "dell-pe1953.corp.vmturbo.com",
            "className": "PhysicalMachine",
            "severity": "Critical"
        }
    ],
    "value": "1",
    "projectionDays": [
        0
    ]
},
{
    "index": 5,
    "type": "REMOVED",
    "description": "dell-pe1954.corp.vmturbo.com",
    "targets": [
        {
            "uuid": "4C4C4544-0059-4D10-8030-B3C04F464331",
            "displayName": "dell-pe1954.corp.vmturbo.com",
            "className": "PhysicalMachine",
            "severity": "Critical"
        }
    ],
    "value": "1",
    "projectionDays": [
        0
    ]
},
{
    "index": 6,
    "type": "SET_ACTION_SETTING",
    "description": "Provision for PhysicalMachine disabled",
    "targets": [
        {
            "uuid": "PhysicalMachine"
        }
    ],
    "value": "PhysicalMachine",
    "enable": false,
    "name": "provision",
    "projectionDays": [
        0
    ]
}
},
{
    "timebasedTopologyChanges": {}
}

```

```
}
```

Migrate to Cloud

POST:

```
{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "Migrate to Public Cloud- Basic",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [
    0
  ],
  "scope": [
    {
      "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
      "displayName": "ACM_vm",
      "groupType": "VirtualMachine",
      "className": "Group"
    },
    {
      "uuid": "_lRrTYB--EeewItqBJctLGw",
      "displayName": "All Cloud Zones",
      "groupType": "PhysicalMachine",
      "className": "Group"
    }
  ],
  "topologyChanges": {
    "addList": [],
    "migrateList": [
      {
        "projectionDay": 0,
        "source": {
          "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
          "displayName": "ACM_vm",
          "className": "VirtualMachine"
        },
        "destination": {
          "uuid": "_lRrTYB--EeewItqBJctLGw",
          "displayName": "All Cloud Zones",
          "className": "PhysicalMachine"
        }
      }
    ],
    "removeList": [
      {
        "projectionDay": 0,
        "target": {
          "uuid": "_nuoxwETSEemi-4wSMH00WA",
          "displayName": "All VMs In All Cloud Zones",
          "className": "VirtualMachine"
        }
      }
    ],
    "replaceList": [],
    "relievePressureList": []
  },
  "type": "CLOUD_MIGRATION"
}
```

Response:

```
{
  "uuid": "2502081867536",
  "displayName": "Migrate to Public Cloud- Basic",
  "owners": [
```

```

{
  "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
  "username": "administrator",
  "showSharedUserSC": false
}
],
"type": "CLOUD_MIGRATION",
"scope": [
  {
    "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
    "displayName": "ACM_vm",
    "className": "Group",
    "groupType": "VirtualMachine",
    "isStatic": true,
    "logicalOperator": "AND"
  },
  {
    "uuid": "_1RrTYB--EeewItqBJctLGw",
    "displayName": "All Cloud Zones",
    "className": "Group",
    "groupType": "PhysicalMachine",
    "isStatic": true,
    "logicalOperator": "AND"
  }
],
"projectionDays": [
  0
],
"topologyChanges": {
  "removeList": [
    {
      "projectionDay": 0,
      "target": {
        "uuid": "_nuoxwETSEemi-4wSMH00WA",
        "displayName": "All VMs In All Cloud Zones",
        "className": "Group"
      }
    }
  ],
  "migrateList": [
    {
      "projectionDay": 0,
      "source": {
        "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
        "displayName": "ACM_vm",
        "className": "Group"
      },
      "destination": {
        "uuid": "_1RrTYB--EeewItqBJctLGw",
        "displayName": "All Cloud Zones",
        "className": "Group"
      }
    }
  ]
},
"loadChanges": {},
"configChanges": {
  "osMigrationSettingList": [
    {
      "uuid": "matchToSource",
      "value": "true"
    }
  ]
},
"changes": [
  {
    "index": 1,
    "type": "SCOPE",
    "scope": [
      {
        "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
        "displayName": "ACM_vm",
        "className": "Group",
        "entitiesCount": 83,
        "groupType": "VirtualMachine",
        "severity": "Major",
        "logicalOperator": "AND"
      },
      {
        "uuid": "_1RrTYB--EeewItqBJctLGw",
        "displayName": "All Cloud Zones",
        "className": "Group",

```



```

        "entitiesCount": 78,
        "groupType": "PhysicalMachine",
        "severity": "Normal",
        "logicalOperator": "AND"
    }
}
},
{
    "index": 2,
    "type": "PROJECTION_PERIODS",
    "projectionDays": [
        0
    ]
},
{
    "index": 3,
    "type": "REMOVED",
    "description": "All VMs In All Cloud Zones",
    "targets": [
        {
            "uuid": "_nuoxwETSEemi-4wSMH00WA",
            "displayName": "All VMs In All Cloud Zones",
            "className": "Group",
            "entitiesCount": 154,
            "groupType": "VirtualMachine",
            "severity": "Major",
            "logicalOperator": "AND"
        }
    ],
    "value": "1",
    "projectionDays": [
        0
    ]
},
{
    "index": 4,
    "type": "MIGRATION",
    "description": "Migrate [ACM_vm] to All Cloud Zones",
    "targets": [
        {
            "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
            "displayName": "ACM_vm",
            "className": "Group",
            "entitiesCount": 83,
            "groupType": "VirtualMachine",
            "severity": "Major",
            "logicalOperator": "AND"
        },
        {
            "uuid": "_lRrTYB--EeewItqBJctLGw",
            "displayName": "All Cloud Zones",
            "className": "Group",
            "entitiesCount": 78,
            "groupType": "PhysicalMachine",
            "severity": "Normal",
            "logicalOperator": "AND"
        }
    ],
    "projectionDays": [
        0
    ]
},
{
    "index": 5,
    "type": "SET_TARGET_OS",
    "targets": [
        {
            "uuid": "4656c0ba6b976d05d1a9470ee673672022e8e926",
            "displayName": "ACM_vm",
            "className": "Group",
            "entitiesCount": 83,
            "groupType": "VirtualMachine",
            "severity": "Major",
            "logicalOperator": "AND"
        }
    ],
    "projectionDays": [
        0
    ]
}
},
{
    "timebasedTopologyChanges": {}
}

```

```
}
```

Optimize Cloud

POST:

```
{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [
      {
        "uuid": "resize",
        "displayName": "resize for VMS enabled",
        "value": "true",
        "entityType": "VirtualMachine"
      }
    ],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [
      {
        "uuid": "preferredOfferingClass",
        "displayName": "Type",
        "value": "STANDARD",
        "entityType": "STANDARD"
      },
      {
        "uuid": "preferredTerm",
        "displayName": "Term",
        "value": "YEARS_3",
        "entityType": "YEARS_3"
      },
      {
        "uuid": "preferredPaymentOption",
        "displayName": "Payment",
        "value": "ALL_UPFRONT",
        "entityType": "ALL_UPFRONT"
      },
      {
        "uuid": "preferredCoverage",
        "displayName": "Coverage",
        "value": "80",
        "entityType": "80"
      },
      {
        "uuid": "riCoverageOverride",
        "displayName": "RI Coverage Override",
        "value": "false",
        "entityType": "false"
      }
    ],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "Optimize Cloud- Basic",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [
    0
  ],
  "scope": [
    {
      "uuid": "GROUP-PMsByTargetType_AWS",
      "displayName": "PMs_AWS",
      "groupType": "PhysicalMachine",
      "className": "Group"
    }
  ],
  "topologyChanges": {
    "addList": [],
    "migrateList": [],
    "removeList": [],
    "replaceList": [],
    "relievePressureList": []
  },
  "type": "OPTIMIZE_CLOUD"
}
```

```
}
```

Response:

```
{
  "uuid": "2502117573632",
  "displayName": "Optimize Cloud- Basic",
  "owners": [
    {
      "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
      "username": "administrator",
      "showSharedUserSC": false
    }
  ],
  "type": "OPTIMIZE_CLOUD",
  "scope": [
    {
      "uuid": "be95c99fc2a2195ac896204766a52d0e141818a6",
      "displayName": "PMS_AWS",
      "className": "Group",
      "groupType": "PhysicalMachine",
      "isStatic": true,
      "logicalOperator": "AND"
    }
  ],
  "projectionDays": [
    0
  ],
  "topologyChanges": {},
  "loadChanges": {},
  "configChanges": {
    "automationSettingList": [
      {
        "uuid": "resize",
        "displayName": "resize",
        "value": "true"
      }
    ],
    "riSettingList": [
      {
        "uuid": "preferredPaymentOption",
        "displayName": "Payment",
        "value": "ALL_UPFRONT",
        "defaultValue": "ALL_UPFRONT",
        "valueType": "STRING",
        "options": [
          {
            "label": "ALL_UPFRONT",
            "value": "ALL_UPFRONT"
          },
          {
            "label": "PARTIAL_UPFRONT",
            "value": "PARTIAL_UPFRONT"
          },
          {
            "label": "NO_UPFRONT",
            "value": "NO_UPFRONT"
          }
        ]
      },
      {
        "sourceGroupName": "Global"
      }
    ],
    {
      "uuid": "preferredTerm",
      "displayName": "Term",
      "value": "YEARS_3",
      "defaultValue": "YEARS_1",
      "valueType": "STRING",
      "options": [
        {
          "label": "YEARS_1",
          "value": "YEARS_1"
        },
        {
          "label": "YEARS_3",
          "value": "YEARS_3"
        }
      ],
      {
        "sourceGroupName": "Global"
      }
    ]
  }
}
```

```

{
  "uuid": "preferredCoverage",
  "displayName": "Coverage",
  "value": "80",
  "defaultValue": "80",
  "valueType": "NUMERIC",
  "min": 0,
  "max": 100,
  "sourceGroupName": "Global"
},
{
  "uuid": "riCoverageOverride",
  "displayName": "RI Coverage Override",
  "value": "false",
  "defaultValue": "false",
  "valueType": "BOOLEAN",
  "sourceGroupName": "Global"
},
{
  "uuid": "preferredOfferingClass",
  "displayName": "Type",
  "value": "STANDARD",
  "defaultValue": "STANDARD",
  "valueType": "STRING",
  "options": [
    {
      "label": "STANDARD",
      "value": "STANDARD"
    },
    {
      "label": "CONVERTIBLE",
      "value": "CONVERTIBLE"
    }
  ],
  "sourceGroupName": "Global"
}
]
},
"changes": [
{
  "index": 1,
  "type": "SCOPE",
  "scope": [
    {
      "uuid": "be95c99fc2a2195ac896204766a52d0e141818a6",
      "displayName": "PMs_AWS",
      "className": "Group",
      "entitiesCount": 50,
      "groupType": "PhysicalMachine",
      "severity": "Normal",
      "logicalOperator": "AND"
    }
  ]
},
{
  "index": 2,
  "type": "PROJECTION_PERIODS",
  "projectionDays": [
    0
  ]
},
{
  "index": 3,
  "type": "ENABLED",
  "description": "Resize enabled",
  "targets": [],
  "enable": true,
  "projectionDays": [
    0
  ]
},
{
  "index": 4,
  "type": "RI_SETTINGS",
  "targets": [
    {
      "uuid": "preferredPaymentOption|ALL_UPFRONT"
    },
    {
      "uuid": "preferredTerm|YEARS_3"
    }
  ]
}
]
}

```

```

        "uuid": "preferredCoverage|80"
      },
      {
        "uuid": "riCoverageOverride|false"
      },
      {
        "uuid": "preferredOfferingClass|STANDARD"
      }
    ],
    "projectionDays": [
      0
    ]
  },
  "timebasedTopologyChanges": {}
}

```

On-Prem Workload Migration (Cluster to Cluster)

POST:

```

{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "On-Prem Workload Migration 1",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [
    0
  ],
  "scope": [
    {
      "uuid": "3e47ff3351f3247367c00c08fdc5bb974695c443",
      "displayName": "DC23-Datacenter\\DC23-cluster1",
      "groupType": "PhysicalMachine",
      "className": "Cluster"
    }
  ],
  "topologyChanges": {
    "addList": [
      {
        "count": 1,
        "projectionDays": [
          0
        ],
        "target": {
          "uuid": "67d24a6f265151876e87f39475fb4ee4b4170098",
          "displayName": "AvailabilitySet::ARSEN-AVS-NCUS",
          "className": "VirtualMachine"
        }
      }
    ],
    "migrateList": [],
    "removeList": [],
    "replaceList": [],
    "relievePressureList": []
  },
  "type": "WORKLOAD_MIGRATION"
}

```

Response:

```

{
  "uuid": "2502063893936",
  "displayName": "On-Prem Workload Migration- Basic",
  "owners": [
    {
      "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",

```

```

        "username": "administrator",
        "showSharedUserSC": false
    },
    ],
    "type": "WORKLOAD_MIGRATION",
    "scope": [
        {
            "uuid": "_0x30YUg1Ed-gHc4L513y0A",
            "displayName": "Market",
            "className": "Market"
        }
    ],
    "projectionDays": [
        0
    ],
    "topologyChanges": {
        "addList": [
            {
                "projectionDays": [
                    0
                ],
                "target": {
                    "uuid": "a6d365f4fbf03fb9a2e8cdb29e38045e31cee41b",
                    "displayName": "Beta DC6_vm",
                    "className": "Group"
                },
                "count": 1
            }
        ]
    },
    "loadChanges": {},
    "configChanges": {},
    "changes": [
        {
            "index": 1,
            "type": "SCOPE",
            "scope": [
                {
                    "uuid": "_0x30YUg1Ed-gHc4L513y0A",
                    "displayName": "Market",
                    "className": "Market"
                }
            ]
        },
        {
            "index": 2,
            "type": "PROJECTION_PERIODS",
            "projectionDays": [
                0
            ]
        },
        {
            "index": 3,
            "type": "ADDED",
            "description": "1 Beta DC6_vm",
            "targets": [
                {
                    "uuid": "a6d365f4fbf03fb9a2e8cdb29e38045e31cee41b",
                    "displayName": "Beta DC6_vm",
                    "className": "Group",
                    "entitiesCount": 56,
                    "groupType": "VirtualMachine",
                    "severity": "Major",
                    "logicalOperator": "AND"
                }
            ],
            "value": "1",
            "projectionDays": [
                0
            ]
        }
    ],
    "timebasedTopologyChanges": {}
}

```

Hardware Refresh

POST:

```

{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "Hardware Refresh- Basic",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [
    0
  ],
  "scope": [
    {
      "uuid": "Market",
      "displayName": "Global Environment",
      "className": "Market"
    }
  ],
  "topologyChanges": {
    "addList": [],
    "migratelist": [],
    "removelist": [],
    "replaceList": [
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-0042-5A10-804A-B1C04F384331",
          "displayName": "dell-pe1944.corp.vmturbo.com",
          "className": "PhysicalMachine",
          "severity": "Critical"
        },
        "template": {
          "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
          "displayName": "HP_DL580 G7",
          "className": "PhysicalMachineProfile"
        }
      },
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-004A-3610-8057-C8C04F464331",
          "displayName": "dell-pe1953.corp.vmturbo.com",
          "className": "PhysicalMachine",
          "severity": "Critical"
        },
        "template": {
          "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
          "displayName": "HP_DL580 G7",
          "className": "PhysicalMachineProfile"
        }
      },
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-0059-4D10-8030-B3C04F464331",
          "displayName": "dell-pe1954.corp.vmturbo.com",
          "className": "PhysicalMachine",
          "severity": "Critical"
        },
        "template": {
          "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
          "displayName": "HP_DL580 G7",
          "className": "PhysicalMachineProfile"
        }
      },
      {
        "projectionDay": 0,
        "target": {
          "uuid": "Virtual_ESX_4238e933-3923-8334-37fe-3aec8fbd046f",
          "displayName": "hp-esx22.dev.mycorp.com",
          "className": "PhysicalMachine",
          "severity": "Critical"
        }
      }
    ]
  }
}

```

```

    },
    "template": {
      "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
      "displayName": "HP_DL580 G7",
      "className": "PhysicalMachineProfile"
    }
  },
  "relievePressureList": []
},
{
  "type": "RECONFIGURE_HARDWARE"
}
}

```

Response:

```

{
  "uuid": "2502070918448",
  "displayName": "Hardware Refresh- Basic",
  "owners": [
    {
      "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
      "username": "administrator",
      "showSharedUserSC": false
    }
  ],
  "type": "RECONFIGURE_HARDWARE",
  "scope": [
    {
      "uuid": "_0x30YUg1Ed-gHc4L513y0A",
      "displayName": "Market",
      "className": "Market"
    }
  ],
  "projectionDays": [
    0
  ],
  "topologyChanges": {
    "replaceList": [
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-0042-5A10-804A-B1C04F384331",
          "displayName": "dell-pe1944.corp.vmturbo.com",
          "className": "PhysicalMachine"
        },
        "template": {
          "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
          "displayName": "HP_DL580 G7",
          "className": "PhysicalMachineProfile"
        }
      },
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-004A-3610-8057-C8C04F464331",
          "displayName": "dell-pe1953.corp.vmturbo.com",
          "className": "PhysicalMachine"
        },
        "template": {
          "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
          "displayName": "HP_DL580 G7",
          "className": "PhysicalMachineProfile"
        }
      },
      {
        "projectionDay": 0,
        "target": {
          "uuid": "4C4C4544-0059-4D10-8030-B3C04F464331",
          "displayName": "dell-pe1954.corp.vmturbo.com",
          "className": "PhysicalMachine"
        },
        "template": {
          "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
          "displayName": "HP_DL580 G7",
          "className": "PhysicalMachineProfile"
        }
      }
    ]
  },
  "projectionDay": 0,
}

```



```

        "target": {
          "uuid": "Virtual_ESX_4238e933-3923-8334-37fe-3aec8fbd046f",
          "displayName": "hp-esx22.dev.mycorp.com",
          "className": "PhysicalMachine"
        },
        "template": {
          "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
          "displayName": "HP_DL580 G7",
          "className": "PhysicalMachineProfile"
        }
      }
    ],
    "loadChanges": {},
    "configChanges": {},
    "changes": [
      {
        "index": 1,
        "type": "SCOPE",
        "scope": [
          {
            "uuid": "_0x30YUglEd-gHc4L513y0A",
            "displayName": "Market",
            "className": "Market"
          }
        ]
      },
      {
        "index": 2,
        "type": "PROJECTION_PERIODS",
        "projectionDays": [
          0
        ]
      },
      {
        "index": 3,
        "type": "REPLACED",
        "description": "Replace [dell-pe1944.corp.vmturbo.com, dell-pe1953.corp.vmturbo.com, dell-pe1954.corp.vmturbo.com, hp-esx... with HP_DL580 G7",
        "targets": [
          {
            "uuid": "4C4C4544-0042-5A10-804A-B1C04F384331",
            "displayName": "dell-pe1944.corp.vmturbo.com",
            "className": "PhysicalMachine",
            "severity": "Critical"
          },
          {
            "uuid": "4C4C4544-004A-3610-8057-C8C04F464331",
            "displayName": "dell-pe1953.corp.vmturbo.com",
            "className": "PhysicalMachine",
            "severity": "Critical"
          },
          {
            "uuid": "4C4C4544-0059-4D10-8030-B3C04F464331",
            "displayName": "dell-pe1954.corp.vmturbo.com",
            "className": "PhysicalMachine",
            "severity": "Critical"
          },
          {
            "uuid": "Virtual_ESX_4238e933-3923-8334-37fe-3aec8fbd046f",
            "displayName": "hp-esx22.dev.mycorp.com",
            "className": "PhysicalMachine",
            "severity": "Critical"
          },
          {
            "uuid": "_juCtwJkfEeCX4rLBy_KD2g",
            "displayName": "HP_DL580 G7",
            "className": "PhysicalMachineProfile"
          }
        ]
      },
      {
        "value": "0",
        "projectionDays": [
          0
        ]
      }
    ],
    "timebasedTopologyChanges": {}
  }
}

```

POST:

```

{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "Alleviate Pressure- Basic",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [
    0
  ],
  "scope": [
    {
      "uuid": "11c63ebd77647e7b9c9fb85dd2d4c77464cbeac2",
      "displayName": "DC13\\DC13-Cluster",
      "className": "Cluster"
    },
    {
      "uuid": "57a4026a69ba4b46ebc430cb62d5c55eeea00695",
      "displayName": "DC13\\Physical Hosts_Cluster2 - Intel",
      "className": "Cluster"
    }
  ],
  "topologyChanges": {
    "addList": [],
    "migrateList": [],
    "removeList": [],
    "replaceList": [],
    "relievePressureList": [
      {
        "projectionDay": 0,
        "sources": [
          {
            "uuid": "11c63ebd77647e7b9c9fb85dd2d4c77464cbeac2",
            "displayName": "DC13\\DC13-Cluster",
            "className": "Cluster"
          }
        ],
        "destinations": [
          {
            "uuid": "57a4026a69ba4b46ebc430cb62d5c55eeea00695",
            "displayName": "DC13\\Physical Hosts_Cluster2 - Intel",
            "className": "Cluster"
          }
        ]
      }
    ]
  },
  "type": "ALLEVIATE_PRESSURE"
}

```

Response:

```

{
  "uuid": "2531404249984",
  "displayName": "On-Prem Workload Migration 1",
  "owners": [
    {
      "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
      "username": "administrator",
      "showSharedUserSC": false
    }
  ],
  "type": "WORKLOAD_MIGRATION",
  "scope": [
    {
      "uuid": "3e47ff3351f3247367c00c08fdc5bb974695c443",
      "displayName": "DC23-Datacenter\\DC23-cluster1",
      "className": "Cluster",
      "groupType": "PhysicalMachine",
    }
  ]
}

```

```

        "isStatic": true,
        "logicalOperator": "AND"
    },
    ],
    "projectionDays": [
        0
    ],
    ],
    "topologyChanges": {
        "addList": [
            {
                "projectionDays": [
                    0
                ],
                "target": {
                    "uuid": "67d24a6f265151876e87f39475fb4ee4b4170098",
                    "displayName": "AvailabilitySet::ARSEN-AVS-NCUS",
                    "className": "DiscoveredGroup"
                },
                "count": 1
            }
        ]
    },
    "loadChanges": {},
    "configChanges": {},
    "changes": [
        {
            "index": 1,
            "type": "SCOPE",
            "scope": [
                {
                    "uuid": "3e47ff3351f3247367c00c08fdc5bb974695c443",
                    "displayName": "DC23-Datacenter\\DC23-cluster1",
                    "className": "Cluster",
                    "entitiesCount": 3,
                    "groupType": "PhysicalMachine",
                    "severity": "Critical",
                    "logicalOperator": "AND"
                }
            ]
        },
        {
            "index": 2,
            "type": "PROJECTION_PERIODS",
            "projectionDays": [
                0
            ]
        },
        {
            "index": 3,
            "type": "ADDED",
            "description": "1 AvailabilitySet::ARSEN-AVS-NCUS",
            "targets": [
                {
                    "uuid": "67d24a6f265151876e87f39475fb4ee4b4170098",
                    "displayName": "AvailabilitySet::ARSEN-AVS-NCUS",
                    "className": "DiscoveredGroup",
                    "entitiesCount": 3,
                    "groupType": "VirtualMachine",
                    "severity": "Critical",
                    "logicalOperator": "AND"
                }
            ],
            "value": "1",
            "projectionDays": [
                0
            ]
        }
    ],
    "timebasedTopologyChanges": {}
}

```

Optimize Current Environment

The result of a plan run with no custom configuration is an optimization of your current environment, respecting all current policies and constraints.

POST:

```

{
  "configChanges": {
    "addPolicyList": [],
    "automationSettingList": [],
    "removeConstraintList": [],
    "removePolicyList": [],
    "riSettingList": [],
    "osMigrationSettingList": [],
    "subscription": {}
  },
  "displayName": "Custom- No Config",
  "loadChanges": {
    "utilizationList": [],
    "maxUtilizationList": []
  },
  "projectionDays": [],
  "scope": [
    {
      "uuid": "Market",
      "displayName": "Global Environment",
      "className": "Market"
    }
  ],
  "topologyChanges": {
    "addList": [],
    "migrateList": [],
    "removeList": [],
    "replaceList": [],
    "relievePressureList": []
  },
  "type": "CUSTOM"
}

```

Response:

```

{
  "uuid": "2502119526800",
  "displayName": "Custom- No Config",
  "owners": [
    {
      "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
      "username": "administrator",
      "showSharedUserSC": false
    }
  ],
  "type": "CUSTOM",
  "scope": [
    {
      "uuid": "_0x30YUg1Ed-gHc4L513y0A",
      "displayName": "Market",
      "className": "Market"
    }
  ],
  "changes": [
    {
      "index": 1,
      "type": "SCOPE",
      "scope": [
        {
          "uuid": "_0x30YUg1Ed-gHc4L513y0A",
          "displayName": "Market",
          "className": "Market"
        }
      ]
    }
  ]
}

```

Scenario Future Load Configuration Example

Future Load Plans

Future load plans are a type of plan in which commodities from active VMs are taken and applied to passive or low-workload VMs, simulating the effect on the environment if these passive VMs became active. For example, you may want to investigate the effect on your environment if your disaster recovery VMs were forced to run at historical peak values. In this case, the production VMs whose commodities will be used are the active VMs, and the currently idle disaster recovery VMs are the passive VMs.

Currently, there are two future load plan types:

- **PEAKOFPEAKS**

The peak-of-peaks future load plan replicates in the passive VMs every commodity of the active VMs reaching its historical peak utilization simultaneously, and the plan result will reflect the effect on your environment.

- **CUSTOM**

The custom future load plan replicates in the passive VMs every commodity of the active VMs reaching its current utilization simultaneously, and the plan result will reflect the effect on your environment.

The setup and configuration for both future load plans differ only in the content of the type parameter- all other steps will be identical.

The settings you make in a scenario correspond to the plan settings you can make in the user interface. These include:

- Plan scope
- Changes to workload (adding, removing, or replacing VMs or containers)
- Changes to supply (adding, removing, replacing PMs or storage)
- Enable/disable placement policies and other constraints
- Changes to action modes
- Enable/disable provisioning of supply
- Enable/disable resizing of workloads

Future Load Prerequisites

In order to run a future load plan, you must retrieve statistics for the entities to be included in the plan. Typically, this is done utilizing the POST /markets/market_uuid/entities/stats request, with startDate and scopes parameters.

Example input for statistic retrieval:

```
{
  "period": {
    "startDate": 1237056032
  },
  "scopes": [
    "4223ae0c-c99b-f6ca-c1ef-3f367bdf5528",
    "4223bb37-0090-f332-0140-cc3cce7b3735",
    "4223dc55-78f2-2cd7-9abf-b09b1be835b4",
    "42231932-83af-10d9-f0cd-26c8a08a9e18",
    "422374a3-2c64-b613-a9a7-1f900a2314b4"
  ]
}
```

Once the call is completed, copy the response in its entirety- or if using Swagger, click the Download button next to the response and copy the contents of the file.

Running the Future Load Plan

After creating the ScenarioApiDTO, the response will include the uuid of the created scenario. Use this uuid along with the uuid of the market to run the plan against (typically the real-time market) in the POST /markets/market_uuid/scenarios/scenario_uuid request.

Viewing the Peak of Peak Plan

After running the plan, the response will include the uuid of the created plan market, which you should note. Results can be viewed using the GET /markets/market_uuid request.

Schedules Endpoint

Turbonomic schedules specify a specific time range during which certain events can occur. Turbonomic currently uses schedules in scoped policies to set up windows of time when the policy can execute certain actions, or when the policy changes settings that affect analysis and action generation.

Note: When you configure a schedule window for a resize action, to ensure Turbonomic will execute the action during the scheduled time, you must turn off the Enforce Non Disruptive Mode setting for that scheduled policy. Even if you turn the setting off for the global policy, you still must turn the setting off for your scheduled policy. Otherwise Turbonomic will not execute the resize action.

Using the schedules endpoint, you can:

- Get a list of all schedules
- Get a specified schedule
- Create a new schedule
- Edit a schedule
- Delete a license
- View all policies using a specified schedule

Schedules Requests

Getting Schedules

Gets a list of schedules. For a list of schedules, the API returns an array of ScheduleApiDTOs. Each ScheduleApiDTO will contain details about the schedule, including the start and end time and date and recurrence. To get a single schedule, include the UUID of the notification in the request.

Examples:

- **All Schedules:** GET https://10.10.10.10/api/v3/schedules
- **Single Schedule:** GET https://10.10.10.10/api/v3/schedules/284466929277824

Response:

```
[
  {
    "uuid": "284466927892512",
    "displayName": "DalSched1",
    "startTime": "2020-02-29T16:30",
    "endTime": "2020-02-29T19:30",
    "recurrence": {
      "type": "WEEKLY",
      "daysOfWeek": [
        "Mon",
        "Fri"
      ],
      "interval": 1
    },
    "timeZone": "America/Denver",
    "nextOccurrence": "2020-03-02T16:30:00",
    "nextOccurrenceTimestamp": 1583191800000
  },
]
```

```
{
  "uuid": "284466929277824",
  "displayName": "DalSched2",
  "startTime": "2020-02-29T16:30",
  "endTime": "2020-02-29T17:45",
  "recurrence": {
    "type": "MONTHLY",
    "daysOfMonth": [
      5
    ],
    "interval": 3
  },
  "timeZone": "America/Denver",
  "nextOccurrence": "2020-05-05T16:30:00",
  "nextOccurrenceTimestamp": 1588717800000
}
```

Adding a Schedule

In order to create a schedule in Turbonomic, you must provide a valid ScheduleApiDTO.

Example: POST <https://10.10.10.10/api/v3/schedules>

Example input, showing a schedule to be run weekly on Friday between the hours of 0000 and 0400 that starts on 2019-12-20 and has no end date:

```
{
  "displayName": "DallasSched",
  "endTime": "2019-12-20T04:00",
  "startTime": "2019-12-20T00:00",
  "timeZone": "America/Denver",
  "recurrence": {
    "type": "WEEKLY",
    "interval": 1,
    "daysOfWeek": [
      "Fri"
    ]
  }
}
```

Getting Policies Using a Schedule

Given a schedule ID, retrieve any policies associated with that schedule.

Example: GET <https://10.10.10.10/api/v3/schedules/284466929277824/settingsPolicy>

Response: An array of SettingspolicyApiDTOs that represent the policies using the specified schedule.

```
[
  {
    "uuid": "284466929430656",
    "displayName": "DalStorage",
    "entityType": "Storage",
    "scopes": [
      {
        "uuid": "284460958528132",
        "displayName": "HawthorneHC_datastore",
        "isStatic": true,
        "logicalOperator": "AND"
      }
    ],
    "settingsManagers": [
      {
        "uuid": "automationmanager",
        "displayName": "Action Mode Settings",
        "category": "Automation",
        "settings": [
          {
            "uuid": "suspend",

```

```

        "displayName": "Suspend",
        "value": "MANUAL",
        "defaultValue": "MANUAL",
        "valueType": "STRING",
        "valueObjectType": "String",
        "options": [
            {
                "label": "Disabled",
                "value": "DISABLED"
            },
            {
                "label": "Recommend",
                "value": "RECOMMEND"
            },
            {
                "label": "Manual",
                "value": "MANUAL"
            },
            {
                "label": "Automatic",
                "value": "AUTOMATIC"
            }
        ],
        "entityType": "Storage"
    }
}
],
"schedule": {
    "uuid": "284466929277824",
    "displayName": "DalSched2",
    "startTime": "2020-02-29T16:30",
    "endTime": "2020-02-29T17:45",
    "recurrence": {
        "type": "MONTHLY",
        "daysOfMonth": [
            5
        ],
        "interval": 3
    },
    "timeZone": "America/Denver",
    "nextOccurrence": "2020-05-05T16:30:00",
    "nextOccurrenceTimestamp": 1588717800000
},
"disabled": false,
"readOnly": false,
"default": false
}
]

```

Schedules Endpoint Tips

When creating schedules, you can set multiple timing criteria. Below are schedules with examples of advanced timing. For basic schedules, see the [Schedules Endpoint](#).

Bi-Weekly Schedule with Specific Days

This schedule is set to run biweekly, indicated by the "type": "WEEKLY" and "interval": 2 fields. As indicated by the daysOfWeek array, this schedule is active on Monday, Wednesday, and Friday.

InputDTO:

```

{
    "displayName": "Schedule1",
    "endDate": "2020-07-10",
    "endTime": "2020-05-06T19:30",
    "startTime": "2020-05-06T15:30",
    "timeZone": "America/Denver",
    "recurrence": {
        "type": "WEEKLY",
        "interval": 2,
        "daysOfWeek": [
            "Mon",
            "Wed",
            "Fri"
        ]
    }
}

```



```

    }
  }
}

```

The API response for this schedule:

```

{
  "uuid": "284559431391120",
  "displayName": "DallasTest",
  "endDate": "2020-07-10",
  "startTime": "2020-05-06T15:30",
  "endTime": "2020-05-06T19:30",
  "recurrence": {
    "type": "WEEKLY",
    "daysOfWeek": [
      "Mon",
      "Wed",
      "Fri"
    ],
    "interval": 2
  },
  "timeZone": "America/Denver",
  "nextOccurrence": "2020-05-06T15:30:00",
  "nextOccurrenceTimestamp": 1588800600000
}

```

Six-Month Schedule with Specific Week of the Month

This schedule is set to run every six months, indicated by the "type": "MONTHLY" and "interval": 6 fields. As indicated by the daysOfWeek array this schedule is active on Wednesday, and the "weekOfTheMonth": 2 indicates that this schedule will only run on the second week of the month.

This schedule was created on May 5th, 2020. Converting the timestamp in the API Response to a human-readable date, we see that the next run is on Wednesday, May 13, 2020 3:30:00 PM, the second Wednesday in May.

Input DTO:

```

{
  "displayName": "DallasTest2",
  "endDate": "2020-10-19",
  "endTime": "2020-05-06T19:15",
  "startTime": "2020-05-06T15:30",
  "timeZone": "America/Denver",
  "recurrence": {
    "type": "MONTHLY",
    "interval": 6,
    "daysOfWeek": [
      "Wed"
    ],
    "weekOfTheMonth": [
      2
    ]
  }
}

```

The API response for this schedule:

```

{
  "uuid": "284559434037456",
  "displayName": "DallasTest2",
  "endDate": "2020-10-19",
  "startTime": "2020-05-06T15:30",
  "endTime": "2020-05-06T19:15",
  "recurrence": {
    "type": "MONTHLY",
    "daysOfWeek": [
      "Wed"
    ]
  }
}

```

```

    ],
    "weekOfTheMonth": [
        2
    ],
    "interval": 6
},
{
    "timeZone": "America/Denver",
    "nextOccurrence": "2020-05-13T15:30:00",
    "nextOccurrenceTimestamp": 1589405400000
}
}

```

Getting Policies Attached to a Specific Schedule

In order to see what policies are using a schedule, use the `https://10.10.10.10/api/v3/schedules/{schedule_UUID}/settingsPolicy` request.

Response: An array of `SettingspolicyApiDTOs` that represent the policies using the specified schedule, whose details are also included.

```

[
  {
    "uuid": "284466929430656",
    "displayName": "DalStorage",
    "entityType": "Storage",
    "scopes": [
      {
        "uuid": "284460958528132",
        "displayName": "HawthorneHC_datastore",
        "isStatic": true,
        "logicalOperator": "AND"
      }
    ]
  },
  {
    "settingsManagers": [
      {
        "uuid": "automationmanager",
        "displayName": "Action Mode Settings",
        "category": "Automation",
        "settings": [
          {
            "uuid": "suspend",
            "displayName": "Suspend",
            "value": "MANUAL",
            "defaultValue": "MANUAL",
            "valueType": "STRING",
            "valueObjectType": "String",
            "options": [
              {
                "label": "Disabled",
                "value": "DISABLED"
              },
              {
                "label": "Recommend",
                "value": "RECOMMEND"
              },
              {
                "label": "Manual",
                "value": "MANUAL"
              },
              {
                "label": "Automatic",
                "value": "AUTOMATIC"
              }
            ]
          },
          {
            "entityType": "Storage"
          }
        ]
      }
    ]
  },
  {
    "schedule": {
      "uuid": "284466929277824",
      "displayName": "DalSched2",
      "startTime": "2020-02-29T16:30",
      "endTime": "2020-02-29T17:45",
      "recurrence": {
        "type": "MONTHLY",
        "daysOfMonth": [

```

```

    5
    ],
    "interval": 3
  },
  "timeZone": "America/Denver",
  "nextOccurrence": "2020-05-05T16:30:00",
  "nextOccurrenceTimestamp": 1588717800000
},
"disabled": false,
"readOnly": false,
"default": false
}
]

```

Search Endpoint

A search is a query performed on the entities that participate in the Turbonomic market. The most common use of search is to locate a particular object, service entity, or group of entities that share a characteristic.

Object and Entity refer to different items in your Turbonomic topology:

Using the search endpoint of the Turbonomic API, you can:

- Obtain criteria for use in detailed searching or building groups
- Get detailed information about any object in your Turbonomic environment

Search Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble inputDTOs, or see the potential values of a particular DTO.

The search endpoint contains a utility request that shows the various criteria that you may use to search, for each entity type in the Turbonomic supply chain, and a second that shows the options for a specified criterion. You can then use this information to build your search criteria for more detailed groups.

The available filterTypes depend on the entity making up your search:

VirtualMachine

- vmsByName
- vmsByPMName
- vmsByStorage
- vmsByNetwork
- vmsByApplication
- vmsByDatabaseServer
- vmsByDatabaseServerVersion
- vmsByDC
- vmsByVDC
- vmsByDCnested
- vmsByNumCPUs
- vmsByMem
- vmsByGuestName
- vmsByAltName
- vmsByClusterName
- vmsByDiskArrayName
- vmsByLogicalPoolName
- vmsByTag

- vmsByState
- vmsByBusinessAccountUuid
- vmsByResourceGroupUuid

VirtualDataCenter

- vdcByVDCName
- vdcByVDCName
- vdcByTag
- vdcByState

PhysicalMachine

- pmsByName
- pmsByStorage
- pmsByNetwork
- pmsBySwitch
- pmsByNumVms
- pmsByDC
- pmsByMem
- pmsByNumCPUs
- pmsByVendorName
- pmsByCPUModel
- pmsByModel
- pmsByTimezone
- pmsByClusterName
- pmsByTag
- pmsByState

Storage

- storageByName
- storageByTag
- storageByVMs
- storageByDC
- storageByPMCluster
- storageByState
- volumeByDeletable

Application Component

- appSrvsByName
- appsByName

WebServer

- wbSrvsByName

BusinessApplication

- busAppsByName

Database

- databaseByName
- databaseByTag

- databaseByBusinessAccountUuid
- databaseByResourceGroupUuid

DatabaseServer

- databaseServerByName
- databaseServerByTag
- databaseServerByBusinessAccountUuid
- databaseServerByEngine
- databaseServerByEdition
- databaseServerByVersion

VirtualApplication

- vappsByName

Cluster

- clustersByName
- clustersByTag

DataCenter

- datacentersByName
- datacentersByTag

Group

- groupsByName

StorageCluster

- storageClustersByName

DiskArray

- diskarrayByName

Zone

- zonsByName

Region

- regsByName

Network

- netsByName

LoadBalancer

- lbsByName

Chassis

- chasByName

StorageController

- storagecontrollerByName

DPod

- dpodByName

VPod

- vpodByName

LogicalPool

- logicalPoolByName

Switch

- switchByName

Container

- containersByName
- containersByPodName
- containersByVMName
- containersByNamespace
- containerSpecsByName

ContainerPod

- containerPodsByName
- containerPodsByNamespace
- containerPodsByVMName

ServiceEntity

Note: Groups of type ServiceEntity are the only groups that have multiple entity types, and are used exclusively for cloud targets.

- workloadByBusinessAccountUuid
- workloadByResourceGroupUuid

Workload

- workloadByBusinessAccountUuid
- workloadByResourceGroupUuid
- workloadControllersByName
- workloadControllersByNamespace
- workloadControllersByKind
- ResourceGroup
- resourceGroupByName
- resourceGroupByUuid
- resourceGroupByBusinessAccountUuid

BusinessAccount

- businessAccountByName
- businessAccountByUuid
- subBusinessAccountOfUuid
- businessAccountValidationStatus
- businessAccountTargetName
- businessAccountCloudProvider

BillingFamily

- billingFamilyByName

ViewPod

- viewPodByName

DesktopPool

- desktopPoolByName
- desktopPoolByViewPod

BusinessUser

- businessUserByDesktopPool
- businessUserByName
- businessUserByViewPod

Cloud-Specific Filters

- computeTiersByName
- computeTiersByMem
- databaseTiersByName
- databaseTiersByDBMem
- databaseServerTiersByName
- databaseServerTiersByVMem

Example: GET <https://10.10.10.10/api/v3/search/criteria>

Response: An array of filter criteria, separated by entity type. For example, this is the filter criteria for Virtual Machine entities:

```
"VirtualMachine": {
  "criteria": [
    {
      "inputType": "*",
      "elements": "displayName",
      "filterCategory": "property",
      "filterType": "vmsByName"
    },
    {
      "inputType": "*",
      "elements": "HostedBy:displayName",
      "filterCategory": "entity",
      "filterType": "vmsByPMName"
    },
    {
      "inputType": "*",
      "elements": "LayeredOver:Storage:displayName",
      "filterCategory": "entity",
      "filterType": "vmsByStorage"
    },
    {
      "inputType": "*",
      "elements": "LayeredOver:Network:displayName",
      "filterCategory": "entity",
      "filterType": "vmsByNetwork"
    },
    {
      "inputType": "*",
      "elements": "Hosts:Application:displayName",
      "filterCategory": "entity",
      "filterType": "vmsByApplication"
    },
    {
      "inputType": "*",
      "elements": "HostedBy:PhysicalMachine:HostedBy:DataCenter:displayName",
      "filterCategory": "entity",
      "filterType": "vmsByDC"
    },
    {
      "inputType": "*",
      "elements": "LayeredOver:VirtualDataCenter:displayName",
      "filterCategory": "entity",
      "filterType": "vmsByVDC"
    },
    {
      "inputType": "*",
      "elements": "AllMemberOf:VirtualDataCenter:displayName",
```

```

    "filterCategory": "entity",
    "filterType": "vmsByDCnested"
  },
  {
    "inputType": "#",
    "elements": "ExtendedBy:VMTopoExt:numCpus",
    "filterCategory": "property",
    "filterType": "vmsByNumCPUs"
  },
  {
    "inputType": "#",
    "elements": "Commodities:VMem:capacity",
    "filterCategory": "property",
    "filterType": "vmsByMem"
  },
  {
    "inputType": "*",
    "elements": "ExtendedBy:VMTopoExt:guestName",
    "filterCategory": "property",
    "filterType": "vmsByGuestName"
  },
  {
    "inputType": "*",
    "elements": "ExtendedBy:VMTopoExt:altName",
    "filterCategory": "property",
    "filterType": "vmsByAltName"
  },
  {
    "inputType": "*",
    "elements": "HostedBy:PhysicalMachine:MemberOf:Cluster:displayName",
    "filterCategory": "entity",
    "filterType": "vmsByClusterName"
  },
  {
    "inputType": "*",
    "elements": "LayeredOver:Storage:LayeredOver:DiskArray:displayName",
    "filterCategory": "entity",
    "filterType": "vmsByDiskArrayName"
  },
  {
    "inputType": "*",
    "elements": "LayeredOver:Storage:LayeredOver:LogicalPool:displayName",
    "filterCategory": "entity",
    "filterType": "vmsByLogicalPoolName"
  },
  {
    "inputType": "*",
    "elements": "tags",
    "filterCategory": "property",
    "filterType": "vmsByTag"
  },
  {
    "inputType": "*",
    "elements": "state",
    "filterCategory": "property",
    "filterType": "vmsByState"
  },
  {
    "inputType": "*",
    "elements": "belongsTo:uuid",
    "filterCategory": "entity",
    "filterType": "vmsByBusinessAccountUuid"
  },
  {
    "inputType": "*",
    "elements": "MemberOf:ResourceGroup:uuid",
    "filterCategory": "entity",
    "filterType": "vmsByResourceGroupUuid"
  }
]
}

```

Getting the Options for a Criterion

For a specific search criterion and entity type, you can get the possible values. For example, you may want to retrieve all tags for a particular group of hosts, or see the available state options for a particular group of virtual machines. This request takes the following parameters:

criteria_key

The criterion to retrieve options for. Currently, Turbonomic accepts the following criteria keys: [state, tags]. Any other input that returns results should be considered internal or early access, and should not be relied on for scripting purposes.

scopes

The UUID of the scope to retrieve the criterion values for. For example, to retrieve all tags for virtual machines in a particular cluster, put the cluster UUID here.

entity_type

The entity whose state or tag options will be returned. For example, if scopes is passed with the UUID of a cluster, and this parameter is passed with a value of VirtualMachine, the request will return the options for each virtual machine in that cluster.

order_by

The field to order the results by. [creation_date, name, risk_category, savings, severity].

ascending

Default: true. When false, results will be in descending order.

environment_type

Returns only objects in the specified environment type. [Cloud, Hybrid, Onprem]

Example: GET https://10.10.10.10/api/v3/search/criteria/state/options?scopes=7c8d50fae46c09b68b00916411469770304226b4&entity_type=VirtualMachine

Response: A CriteriaOptionApiDTO with the available options. For example, the response below indicates that all virtual machines on the cluster whose UUID was passed are either in active or idle states.

```
[
  {
    "value": "ACTIVE"
  },
  {
    "value": "IDLE"
  }
]
```

Search Requests

Getting Object Information by UUID

Gets information about any object in your Turbonomic environment.

Object and Entity refer to different items in your Turbonomic topology:

Note:

If you set the objectType parameter has a value of Group, the response will include objects related to an entity that perform grouping. For example, resource groups and clusters both perform grouping, and will be included in the response.

To further refine your search, include a value for the group_type parameter. This parameter describes the membership of the group you are searching for. For example, a search with an objectType of Group and group_type of VirtualMachine will return all groups of virtual machines in the current scope.

Example: https://10.10.10.10/api/v3/search/Market

Response: A DTO with information about the retrieved object. In this example, the retrieved item is the real-time Market:

```
{
  "links": [
    {
      "rel": "self",
```

```

      "href": "https://10.10.10.10/api/v3/markets/_0x30YUg1Ed-gHc4L513y0A"
    },
    1,
    "uuid": "_0x30YUg1Ed-gHc4L513y0A",
    "displayName": "Market",
    "className": "Market",
    "state": "RUNNING",
    "unplacedEntities": false,
    "environmentType": "HYBRID"
  }
}

```

Note:

When making this request, you can use the `groupBy` parameter to order the results. The `/search` endpoint does not support the `utilization` value for the `groupBy` parameter. When this value is used, the API will return the results ordered by `displayName`.

Settings Endpoint

The settings endpoint can be used to change settings in a variety of settings managers. For example, using the `actionscripmanager`, you can change action script settings, and using the `automationmanager`, you can change automation settings on your instance.

Using the settings endpoint of the Turbonomic API, you can:

- Get a list of available setting managers and settings
- Edit a setting

List of Settings Managers

The settings managers available to be modified are:

- `actionscripmanager`
Contains settings related to the use of action scripts.
- `automationmanager`
Contains settings related to action modes for entities in your environment.
- `cloudsavingsmanager`
Contains settings related to execution retention for cloud entities.
- `clusterHeadroomConfig`
Contains settings related to the headroom plans generated by the system.
- `controlmanager`
Contains settings related to workflows that replace native action handling for generated actions in your environment.
- `emailmanager`
Contains settings related to SMTP email notifications.
- `hcisettingsmanager`
Contains settings related to managing hyperconverged infrastructure.
- `marketsettingsmanager`
Contains settings related to market analysis.
- `osmigrationmanager`
Contains settings related to operating system migration for cloud entities.
- `persistencemanager`
Contains settings related to statistic retention data and reporting.
- `reservedinstancemanager`

Contains settings related to reserved instances.

- `storagesettingsmanager`

Contains settings related to storage entity statistics and analysis.

- `telemetrymanager`

Contains settings related to telemetry opt-in and terms of service.

-

For more information about each settingsmanager, execute the GET `https://10.10.10.10/api/v3/settings` request.

Settings Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble inputDTOs, or see the potential values of a particular DTO.

The settings endpoint contains a utility request that shows each settings manager, and the settings available.

Example: GET `https://10.10.10.10/api/v3/settings/`

Response: An array of `SettingsManagerApiDTOs`, where each object is a settings manager and contains the settings for that manager.

Settings Requests

Getting Current Settings for a Specified Settings Manager

Gets the current settings for the specified settings manager. This request is often used to see the settings of a particular settings manager before updating.

Example: GET `https://10.10.10.10/api/v3/settings/automationmanager`

Response: A list of `SettingApiDTOs` representing the settings for the specified settings manager:

```
[
  {
    "uuid": "startVM",
    "displayName": "Start",
    "value": "RECOMMEND",
    "defaultValue": "RECOMMEND",
    "valueType": "STRING",
    "options": [
      {
        "label": "Disabled",
        "value": "DISABLED"
      },
      {
        "label": "Recommend",
        "value": "RECOMMEND"
      },
      {
        "label": "Manual",
        "value": "MANUAL"
      },
      {
        "label": "Automated",
        "value": "AUTOMATIC"
      }
    ],
    "entityType": "VirtualMachine",
    "sourceGroupName": "Global"
  },
  {
    "uuid": "startPM",
    "displayName": "Start",
    "value": "RECOMMEND",
    "defaultValue": "RECOMMEND",
    "valueType": "STRING",
```

```

      "options": [
        {
          "label": "Disabled",
          "value": "DISABLED"
        },
        {
          "label": "Recommend",
          "value": "RECOMMEND"
        },
        {
          "label": "Manual",
          "value": "MANUAL"
        },
        {
          "label": "Automated",
          "value": "AUTOMATIC"
        }
      ],
      "entityType": "PhysicalMachine",
      "sourceGroupName": "Global"
    },
    {
      "uuid": "startDS",
      "displayName": "Start",
      "value": "RECOMMEND",
      "defaultValue": "RECOMMEND",
      "valueType": "STRING",
      "options": [
        {
          "label": "Disabled",
          "value": "DISABLED"
        },
        {
          "label": "Recommend",
          "value": "RECOMMEND"
        },
        {
          "label": "Manual",
          "value": "MANUAL"
        },
        {
          "label": "Automated",
          "value": "AUTOMATIC"
        }
      ],
      "entityType": "Storage",
      "sourceGroupName": "Global"
    },
    ...
  ]

```

Editing Settings

To edit a Setting, pass the new value in the body of this request. This request takes the following parameters:

settingsManager_uuid

The UUID of the settingsmanager whose setting will be changed.

setting_uuid

The setting whose value will be changed.

Example: PUT <https://10.10.10.10/api/v3/settings/automationmanager/moveVM>

Example Input: A SettingApiDTO. In this case, the value is being changed from MANUAL to RECOMMEND:

```

{
  "uuid": "moveVM",
  "displayName": "Move",
  "value": "RECOMMEND",
  "defaultValue": "MANUAL",
  "valueType": "STRING",
  "options": [
    {
      "label": "Disabled",
      "value": "DISABLED"
    }
  ]
}

```

```

    },
    {
      "label": "Recommend",
      "value": "RECOMMEND"
    },
    {
      "label": "Manual",
      "value": "MANUAL"
    },
    {
      "label": "Automated",
      "value": "AUTOMATIC"
    }
  ],
  "entityType": "VirtualMachine",
  "sourceGroupName": "Global"
}

```

Response: The SettingApiDTO reflecting your changes:

```

{
  "uuid": "moveVM",
  "displayName": "Move",
  "value": "RECOMMEND",
  "defaultValue": "MANUAL",
  "valueType": "STRING",
  "options": [
    {
      "label": "Disabled",
      "value": "DISABLED"
    },
    {
      "label": "Recommend",
      "value": "RECOMMEND"
    },
    {
      "label": "Manual",
      "value": "MANUAL"
    },
    {
      "label": "Automated",
      "value": "AUTOMATIC"
    }
  ],
  "entityType": "VirtualMachine",
  "sourceGroupName": "Global"
}

```

Settings Policies Endpoint

A Settings Policy is the collection of settings that apply to an entity. In Turbonomic, there is a default policy for each type of entity. These global defaults are the base settings for entities, and any settings policies that you create will specify deltas to the defaults. Note that you can edit the global policies.

When you create a custom settings policy, you assign a scope to it – one or more groups of entities you want to affect with the policy. For these policies, you specify just the settings that will be different from the defaults.

In addition to global default policies and custom policies, Turbonomic also discovers groups that need special settings, and creates policies for those groups. For example, when Turbonomic discovers Azure Availability Sets and AWS Autoscaling Groups, it generates settings policies for those groups that turn on Consistent Resizing for the group.

Using the settings policies endpoint, you can:

- Get a listing of the settings policies in your environment
- Get details for a single settings policy
- Create settings policies
- Edit settings policies

- Delete settings policies

Settings Policies Requests

Getting Settings Policies

This call returns an array of SettingsPolicyApiDTOs for all the settings policies in your environment. You can pass entity types to limit the listing to policies for those types, and you can limit the list to only default policies.

This request takes the following parameters:

only_defaults

If this is true, the call only gets the default settings policies

entity_type

One or more entity types to limit the list of settings policies

Examples:

- Get all the settings policies: GET <https://10.10.10.10/api/v3/settingspolicies>
- Get all the default settings policies: GET https://10.10.10.10/api/v3/settingspolicies?only_defaults=true
- Get settings policies for VMs and Hosts: GET https://10.10.10.10/api/v3/settingspolicies?entity_type=VirtualMachine&entity_type=PhysicalMachine
- Get a single settings policy (pass the policy Uuid): GET https://10.10.10.10/api/v3/settingspolicies/_aVDEwGegEemDFcIzuV5wcQ

Response: An array of SettingsPolicyApiDTOs. This listing shows the settings policies for Container entities.

```
[
  {
    "uuid": "_vyMHEDnSEemHXrxYkw9y2Q",
    "displayName": "Container defaults",
    "entityType": "Container",
    "settingsManagers": [
      {
        "uuid": "marketsettingsmanager",
        "displayName": "Operational Constraints",
        "category": "Analysis",
        "settings": [
          {
            "uuid": "usedIncrement_Container_VMEM",
            "displayName": "Increment constant for Container VMem [MB]",
            "value": "64.0",
            "defaultValue": "64.0",
            "categories": [
              "resizeRecommendationsConstants"
            ],
            "valueType": "NUMERIC",
            "min": 0,
            "max": 10000000,
            "entityType": "Container",
            "sourceGroupName": "Global"
          },
          {
            "uuid": "usedIncrement_Container_VCPU",
            "displayName": "Increment constant for Container VCPU [MHz]",
            "value": "100.0",
            "defaultValue": "100.0",
            "categories": [
              "resizeRecommendationsConstants"
            ],
            "valueType": "NUMERIC",
            "min": 0,
            "max": 1000000,
            "entityType": "Container",
            "sourceGroupName": "Global"
          }
        ]
      }
    ]
  }
]
```

```

        "uuid": "enforceConsistentResizingContainer",
        "displayName": "Consistent Resizing",
        "value": "false",
        "defaultValue": "false",
        "categories": [
            "resizeRecommendationsConstants"
        ],
        "valueType": "BOOLEAN",
        "entityType": "Container",
        "sourceGroupName": "Global"
    },
    {
        "uuid": "resizeTargetUtilization_Container",
        "displayName": "Resize Target Utilization",
        "value": "0.0",
        "defaultValue": "0.0",
        "valueType": "NUMERIC",
        "min": 0,
        "max": 100,
        "entityType": "Container",
        "sourceGroupName": "Global"
    }
]
...
}
]

```

Creating a Settings Policy

Referenced Endpoint: [Groups](#)

To create a settings policy, you must do the following:

- Specify a policy name,
- Specify whether to enable or disable the policy in your market.
- Set the policy scope – Specify one or more groups of a given entity type. This determines the entity type for the policy.
- For the of settings you want to make, specify the appropriate settings manager, and then specify an array of setting/value pairs.
- Optionally, specify a schedule window and/or action execution schedule for the policy.

To set the policy scope, you provide an array of objects that contain group Uuids. These objects are effectively abbreviated GroupApiDTOs. Note that the groups must all be for the same type of entity. This specifies the entity type for the settings policy. Use the Groups endpoint to get the Uuid values for the groups you want in the scope. For example, to set the scope to a single group of VMs, use the following scopes object:

```

"scopes": [
    {
        "uuid": "_lSlr0GddEemDFcIzuV5wcQ"
    }
]

```

To specify the actual settings, you provide an array of SettingsManagerApiDTOs. Each one contains an array of settings that you want to make. To see all the settings for a given entity type, refer to the user interface, or the User Guide. The setting managers you can choose from are:

- `actionscriptmanager`
Contains settings related to the use of action scripts.
- `automationmanager`
Contains settings related to action modes for entities in your environment.
- `cloudsavingsmanager`
Contains settings related to execution retention for cloud entities.

- `clusterHeadroomConfig`
Contains settings related to the headroom plans generated by the system.
- `controlmanager`
Contains settings related to workflows that replace native action handling for generated actions in your environment.
- `emailmanager`
Contains settings related to SMTP email notifications.
- `hcisettingsmanager`
Contains settings related to managing hyperconverged infrastructure.
- `marketsettingsmanager`
Contains settings related to market analysis.
- `osmigrationmanager`
Contains settings related to operating system migration for cloud entities.
- `persistencemanager`
Contains settings related to statistic retention data and reporting.
- `reservedinstancemanager`
Contains settings related to reserved instances.
- `storagesettingsmanager`
Contains settings related to storage entity statistics and analysis.
- `telemetrymanager`
Contains settings related to telemetry opt-in and terms of service.
-

For example, to set the VM start action to AUTOMATED and to set the VCPU maximum to 16, use the following `settingsManagers` array:

```
"settingsManagers": [
  {
    "uuid": "automationmanager",
    "settings": [
      {
        "uuid": "startVM",
        "value": "AUTOMATIC"
      }
    ]
  },
  {
    "uuid": "marketsettingsmanager",
    "settings": [
      {
        "uuid": "resizeVcpuMaximum_VM",
        "value": 16
      }
    ]
  }
]
```

You can set up a schedule window that determines when the settings policy takes effect. For that you provide a `ScheduleApiDTO` for the schedule details. It includes: the start and end dates, start and end times,

- Start and end dates.
- Start and end times.

- An optional RecurrenceApiDTO for schedule recurrence. If you don't provide this you will specify a one-time schedule window.

For example, use this to specify a "perpetual" schedule window (does not expire until 2099) that starts at 12:30 am and ends at 7:30 am every Saturday and Sunday.

```
"schedule": {
  "startDate": "2019-04-28T00:30:00-04:00",
  "endDate": "2099-12-31T07:30:00-05:00",
  "startTime": "2019-04-28T00:30:00-04:00",
  "endTime": "2019-04-28T07:30:00-04:00",
  "recurrence": {
    "type": "WEEKLY",
    "daysOfWeek": [
      "Sat",
      "Sun"
    ]
  }
}
```

An example complete data payload for a policy with a policy-level schedule, action execution instruction, and action execution schedule is as follows:

```
{
  "disabled": false,
  "entityType": "VirtualMachine",
  "displayName": "TestPol",
  "scopes": [
    {
      "uuid": "285041619454560"
    }
  ],
  "settingsManagers": [
    {
      "uuid": "automationmanager",
      "displayName": "Action Mode Settings",
      "category": "Automation",
      "settings": [
        {
          "uuid": "storageMove",
          "value": "RECOMMEND",
          "valueType": "STRING",
          "valueObjectType": "String",
          "defaultValue": "RECOMMEND",
          "entityType": "VirtualMachine",
          "displayName": "Storage Move",
          "options": [
            {
              "label": "Disabled",
              "value": "DISABLED"
            },
            {
              "label": "Recommend",
              "value": "RECOMMEND"
            },
            {
              "label": "External Approval",
              "value": "EXTERNAL_APPROVAL"
            },
            {
              "label": "Manual",
              "value": "MANUAL"
            },
            {
              "label": "Automatic",
              "value": "AUTOMATIC"
            }
          ]
        }
      ]
    },
    {
      "uuid": "storageMoveExecutionSchedule",
      "value": "285088800975856",
      "valueType": "LIST",
      "valueObjectType": "String",
      "entityType": "VirtualMachine",
      "displayName": "Execution window for Storage Move action"
    }
  ]
}
```

```

    },
    "schedule": {
      "uuid": "285088797821136",
      "displayName": "TestSched",
      "endTime": "2021-05-24T16:00",
      "startTime": "2021-05-24T14:30",
      "timeZone": "America/Chicago",
      "recurrence": {
        "type": "MONTHLY",
        "interval": 1,
        "daysOfMonth": [
          1
        ]
      }
    }
  }
}

```

Example: Using the above payload, POST <https://10.10.10.10/api/v3/settingspolicies>

Response: The settings policy that you created. Use this response to get the policy Uuid.

Editing a Settings Policy

To edit a settings policy, you push a new set of data to the Settings Policies end point. The best way to do this is to copy the SettingsPolicyApiDTO that you want to edit, make changes to that DTO, and then push the DTO out to the API. To remove the policy from the scope, pass the SettingsPolicyApiDTO, and also pass `reset_defaults=true` as a parameter.

This request takes the following parameters:

settingsPolicy_Uuid

The Uuid of the policy you want to edit

reset_defaults

A boolean you can use to reset the policy to default. When `reset_defaults=true`, you remove the policy and reset that scope to default. When you use this setting, pass an empty object `{}` as the data payload.

Examples:

- Assuming you copied a SettingsPolicyApiDTO and then made some changes to it, and pass that at the payload: PUSH https://10.10.10.10/api/v3/settingspolicies/_2-CbQGoNEemy0oIvFZyv1A?reset_defaults=false
- Assuming you want to remove the policy (and so you pass an empty object as the payload): PUSH https://10.10.10.10/api/v3/settingspolicies/_2-CbQGoNEemy0oIvFZyv1A?reset_defaults=true

Response: The modified SettingsPolicyApiDTO.

Deleting a Settings Policy

Deletes the given settings policy.

Example: DELETE https://10.10.10.10/api/v3/settingspolicies/_aV5ucGoTEemy0oIvFZyv1A

Response: 200 for success.

Statistics Endpoint

Statistics Overview

Statistics are pieces of information that Turbonomic discovers while continuously analyzing your environment. The most common use of statistics is to look at a particular statistic over a specific time frame.

Using the stats endpoint of the Turbonomic API, you can:

- Get a list of stats requests in other endpoints
- Get a filtered list of statistics over a specific time frame
- Get a list of statistics for a specified entity
- Get a filtered list of statistics for a specified entity

Statistic Timings

Statistics associated to headroom and capacity planning are written to the Turbonomic database daily, with a timestamp of midnight. Other statistics are collected and stored in the database in ten-minute increments. When retrieving groups of statistics that include both headroom and actively-monitored information, the timestamps returned will reflect the last-written date for each statistic.

Statistics Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble inputDTOs, or see the potential values of a particular DTO.

The stats endpoint contains a utility request that shows common entry points for statistic-related requests. These can be used to obtain statistics for particular entities or groups.

Example: GET <https://10.10.10.10/api/v3/stats>

Response: An array of Link objects, where each object contains a URL to get all statistics for a specified UUID, entity, or group.

Statistics Requests

Getting Statistics for an Entity

Gets all statistics for the specified entity. This request takes the following parameters:

entity_uuid

The entity whose statistics will be returned.

q

Used internally by Turbonomic.

Note:

When you retrieve statistics for a cluster, using the /groups endpoint will return the aggregated statistics for all applicable cluster entities. For individual stats per entity, use the /stats endpoint.

Some statistics are only valid for certain scopes. When you request given statistics for a scope that doesn't include them, the API does not return any data. For example, the numVMs statistic is valid in only the Market and Cluster scopes – the API omits numVMs data from the response when you query other scopes.

Example: <https://10.10.10.10/api/v3/stats/423f26a7-1132-df1c-64e2-8a040480b046>

Response: A list of StatSnapshotApiDTOs representing the current values of the statistics.

```
[
  {
    "displayName": "AdityaReplica",
    "date": "2019-04-24T20:09:46-04:00",
    "statistics": [
      {
        "name": "priceIndex",
        "relatedEntityType": "VirtualMachine",
        "values": {
          "max": 1.01,
          "min": 1.01,
          "avg": 1.01,
          "total": 1.01
        }
      }
    ]
  }
]
```

```

    },
    "value": 1.01
  },
  {
    "displayName": "CPUProvisioned/AdityaReplica",
    "name": "CPUProvisioned",
    "capacity": {
      "max": 3120000,
      "min": 3120000,
      "avg": 3120000,
      "total": 3120000
    },
    "relatedEntityType": "VirtualMachine",
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "units": "MHz",
    "values": {
      "max": 5200,
      "min": 5200,
      "avg": 5200,
      "total": 5200
    },
    "value": 5200
  },
  {
    "displayName": "Swapping/AdityaReplica",
    "name": "Swapping",
    "capacity": {
      "max": 40000000,
      "min": 40000000,
      "avg": 40000000,
      "total": 40000000
    },
    "relatedEntityType": "VirtualMachine",
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "units": "bit/sec",
    "values": {
      "max": 0,
      "min": 0,
      "avg": 0,
      "total": 0
    },
    "value": 0
  },
  {
    "displayName": "NumDisk/AdityaReplica",
    "name": "NumDisk",
    "capacity": {
      "max": 2147483650,
      "min": 2147483650,
      "avg": 2147483650,
      "total": 2147483650
    },
    "relatedEntityType": "VirtualMachine",
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "values": {
      "max": 1,
      "min": 1,
      "avg": 1,
      "total": 1
    },
    "value": 1
  },
  ...
]
}

```

```
]
```

Getting a Filtered List of Statistics

Gets a list of statistics filtered by a `StatPeriodApiInputDTO` that you create. For more information about the criteria that make up the input for this request, see the Swagger documentation for this request, located at https://<Your_Turbonomic_IP>/swagger/external/index.html.

Example: POST <https://10.10.10.10/api/v3/stats/423f26a7-1132-df1c-64e2-8a040480b046>

Example Input: This input will return the values for the VMem, VCPU, and VStorage statistics of the specified entity, ordered first by key, then relatedEntity, then virtualDisk.

```
{
  "statistics": [
    {
      "name": "VMem",
      "groupBy": [
        "key",
        "relatedEntity",
        "virtualDisk"
      ]
    },
    {
      "name": "VCPU",
      "groupBy": [
        "key",
        "relatedEntity",
        "virtualDisk"
      ]
    },
    {
      "name": "VStorage",
      "groupBy": [
        "key",
        "relatedEntity",
        "virtualDisk"
      ]
    }
  ]
}
```

Response: A list of `StatSnapshotApiDTOs` representing the filtered statistics for the entity:

```
[
  {
    "displayName": "AdityaReplica",
    "date": "2019-04-24T20:28:06-04:00",
    "statistics": [
      {
        "displayName": "AdityaReplica",
        "name": "VMem",
        "capacity": {
          "max": 1048576,
          "min": 1048576,
          "avg": 1048576,
          "total": 1048576
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "virtualDisk",
            "value": ""
          },
          {
            "type": "key",
            "value": null
          },
          {
            "type": "relation",
            "value": "sold"
          }
        ]
      },
      {
        "relatedEntity": {

```

```

        "uuid": "5d2f7b69eb3bf506089feba37d31b0c376b02e34",
        "displayName": "GuestLoad[AdityaReplica]",
        "className": "Application"
    },
    {
        "units": "KB",
        "values": {
            "max": 0,
            "min": 0,
            "avg": 0,
            "total": 0
        },
        "value": 0
    },
    {
        "displayName": "AdityaReplica",
        "name": "VCPU",
        "capacity": {
            "max": 5200,
            "min": 5200,
            "avg": 5200,
            "total": 5200
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
            {
                "type": "virtualDisk",
                "value": ""
            },
            {
                "type": "key",
                "value": null
            },
            {
                "type": "relation",
                "value": "sold"
            }
        ],
        "relatedEntity": {
            "uuid": "5d2f7b69eb3bf506089feba37d31b0c376b02e34",
            "displayName": "GuestLoad[AdityaReplica]",
            "className": "Application"
        },
        "units": "MHz",
        "values": {
            "max": 19,
            "min": 14.93,
            "avg": 14.93,
            "total": 14.93
        },
        "value": 14.93
    }
]
}
]

```

Getting a Filtered List of Statistics for All Objects In a Specified Scope

For the specified scope, gets a filtered list of statistics for each entity. If you do not provide any statistics in the input, the response contains basic information about each entity. For more information about the criteria that make up the input for this request, see the Swagger documentation for this request, located at https://<Your_Turbonomic_IP>/swagger/external/index.html.

Example: POST <https://10.10.10.10/api/v3/stats?ascending=true>

Example Input: This input will return the VMem values for each entity in the real-time market from a period of five days prior to the request, to one day prior to the request.

```

{
  "scopes": [
    "Market"
  ],
  "period": {
    "startDate": "-5d",
    "endDate": "-1d",
    "statistics": [
      {

```

```

    "name": "VMem"
  }
]
},
"relatedType": "VirtualMachine"
}

```

Response: A list of StatSnapshotApiDTOs representing the filtered statistics for the entities in the specified scope:

```

[
  {
    "uuid": "4200829c-1272-c0a4-2d17-55f2cc0ef1b4",
    "displayName": "vm-c67a1cdd-609e-4282-809c-e0def5cd0d7a",
    "className": "VirtualMachine",
    "environmentType": "ONPREM",
    "stats": [
      {
        "displayName": "vm-c67a1cdd-609e-4282-809c-e0def5cd0d7a",
        "date": "2019-04-19T00:00:00-04:00",
        "statistics": [
          {
            "name": "VMem",
            "capacity": {
              "max": 16777216,
              "min": 16777216,
              "avg": 16777216,
              "total": 33554432
            },
            "relatedEntityType": "VirtualMachine",
            "filters": [
              {
                "type": "relation",
                "value": "sold"
              }
            ],
            "units": "KB",
            "values": {
              "max": 1509949.5,
              "min": 335544.3,
              "avg": 587202.56,
              "total": 1174405.1
            },
            "value": 587202.56
          }
        ]
      },
      {
        "displayName": "vm-c67a1cdd-609e-4282-809c-e0def5cd0d7a",
        "date": "2019-04-20T00:00:00-04:00",
        "statistics": [
          {
            "name": "VMem",
            "capacity": {
              "max": 16777216,
              "min": 16777216,
              "avg": 16777216,
              "total": 33554432
            },
            "relatedEntityType": "VirtualMachine",
            "filters": [
              {
                "type": "relation",
                "value": "sold"
              }
            ],
            "units": "KB",
            "values": {
              "max": 1509949.5,
              "min": 369098.75,
              "avg": 587202.56,
              "total": 1174405.1
            },
            "value": 587202.56
          }
        ]
      }
    ]
  },
  {
    "displayName": "vm-c67a1cdd-609e-4282-809c-e0def5cd0d7a",

```

```

    "date": "2019-04-22T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 16777216,
          "min": 16777216,
          "avg": 16777216,
          "total": 33554432
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ],
        "units": "KB",
        "values": {
          "max": 12582912,
          "min": 0,
          "avg": 452984.84,
          "total": 905969.7
        },
        "value": 452984.84
      }
    ],
    "displayName": "vm-c67a1cdd-609e-4282-809c-e0def5cd0d7a",
    "date": "2019-04-23T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 16777216,
          "min": 16777216,
          "avg": 16777216,
          "total": 33554432
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ],
        "units": "KB",
        "values": {
          "max": 838860.8,
          "min": 0,
          "avg": 167772.16,
          "total": 335544.3
        },
        "value": 167772.16
      }
    ],
    "uuid": "39EBB726-41D9-4BC8-A41D-CA301854309C",
    "displayName": "Gilad_OM-38071_SMB_VM2",
    "className": "VirtualMachine",
    "environmentType": "ONPREM",
    "uuid": "97A3F420-B7AD-414D-A543-FD308AC774A6",
    "displayName": "Gilad_VMM_Test_VM_2",
    "className": "VirtualMachine",
    "environmentType": "ONPREM",
    "uuid": "4211f183-69a8-3676-3e53-0151365500ff",
    "displayName": "james-ubuntu-dc13",
    "className": "VirtualMachine",
    "environmentType": "ONPREM",
    "stats": [
      {
        "displayName": "james-ubuntu-dc13",
        "date": "2019-04-19T00:00:00-04:00",
        "statistics": [

```



```

    {
      "name": "VMem",
      "capacity": {
        "max": 1048576,
        "min": 1048576,
        "avg": 1048576,
        "total": 2097152
      },
      "relatedEntityType": "VirtualMachine",
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ],
      "units": "KB",
      "values": {
        "max": 83886.08,
        "min": 8388.61,
        "avg": 18874.37,
        "total": 37748.73
      },
      {
        "value": 18874.37
      }
    }
  ],
  {
    "displayName": "james-ubuntu-dc13",
    "date": "2019-04-20T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 1048576,
          "min": 1048576,
          "avg": 1048576,
          "total": 2097152
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ],
        "units": "KB",
        "values": {
          "max": 62914.56,
          "min": 13631.49,
          "avg": 18874.37,
          "total": 37748.73
        },
        {
          "value": 18874.37
        }
      }
    ]
  },
  {
    "displayName": "james-ubuntu-dc13",
    "date": "2019-04-21T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 1048576,
          "min": 1048576,
          "avg": 1048576,
          "total": 2097152
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ],
        "units": "KB",
        "values": {
          "max": 73400.32,
          "min": 11534.34,
          "avg": 17825.79,
          "total": 35651.59
        },
        {
          "value": 17825.79
        }
      }
    ]
  }
]

```

```

        "value": 17825.79
      }
    ]
  },
  {
    "displayName": "james-ubuntu-dc13",
    "date": "2019-04-22T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 1048576,
          "min": 1048576,
          "avg": 1048576,
          "total": 2097152
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ],
        "units": "KB",
        "values": {
          "max": 83886.08,
          "min": 8388.61,
          "avg": 19922.94,
          "total": 39845.89
        },
        "value": 19922.94
      }
    ]
  },
  {
    "displayName": "james-ubuntu-dc13",
    "date": "2019-04-23T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 1048576,
          "min": 1048576,
          "avg": 1048576,
          "total": 2097152
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ],
        "units": "KB",
        "values": {
          "max": 73400.32,
          "min": 3145.73,
          "avg": 18874.37,
          "total": 37748.73
        },
        "value": 18874.37
      }
    ]
  }
]
},
{
  "uuid": "421d2165-36cd-7f6a-3a43-08e09f6f4e0f",
  "displayName": "ACM-LexCorp-Control",
  "className": "VirtualMachine",
  "environmentType": "ONPREM",
  "stats": [
    {
      "displayName": "ACM-LexCorp-Control",
      "date": "2019-04-19T00:00:00-04:00",
      "statistics": [
        {
          "name": "VMem",
          "capacity": {
            "max": 2097152,
            "min": 2097152,
            "avg": 2097152,

```

```

        "total": 4194304
      },
      "relatedEntityType": "VirtualMachine",
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ],
      "units": "KB",
      "values": {
        "max": 167772.16,
        "min": 18874.37,
        "avg": 37748.73,
        "total": 75497.47
      },
      "value": 37748.73
    }
  ],
},
{
  "displayName": "ACM-LexCorp-Control",
  "date": "2019-04-20T00:00:00-04:00",
  "statistics": [
    {
      "name": "VMem",
      "capacity": {
        "max": 2097152,
        "min": 2097152,
        "avg": 2097152,
        "total": 4194304
      },
      "relatedEntityType": "VirtualMachine",
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ],
      "units": "KB",
      "values": {
        "max": 125829.12,
        "min": 18874.37,
        "avg": 37748.73,
        "total": 75497.47
      },
      "value": 37748.73
    }
  ],
},
{
  "displayName": "ACM-LexCorp-Control",
  "date": "2019-04-21T00:00:00-04:00",
  "statistics": [
    {
      "name": "VMem",
      "capacity": {
        "max": 2097152,
        "min": 2097152,
        "avg": 2097152,
        "total": 4194304
      },
      "relatedEntityType": "VirtualMachine",
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ],
      "units": "KB",
      "values": {
        "max": 104857.6,
        "min": 20971.52,
        "avg": 35651.59,
        "total": 71303.17
      },
      "value": 35651.59
    }
  ],
},
{
  "displayName": "ACM-LexCorp-Control",

```

```

    "date": "2019-04-22T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 2097152,
          "min": 2097152,
          "avg": 2097152,
          "total": 4194304
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ]
      },
      {
        "units": "KB",
        "values": {
          "max": 272629.75,
          "min": 20971.52,
          "avg": 73400.32,
          "total": 146800.64
        },
        "value": 73400.32
      }
    ]
  },
  {
    "displayName": "ACM-LexCorp-Control",
    "date": "2019-04-23T00:00:00-04:00",
    "statistics": [
      {
        "name": "VMem",
        "capacity": {
          "max": 2097152,
          "min": 2097152,
          "avg": 2097152,
          "total": 4194304
        },
        "relatedEntityType": "VirtualMachine",
        "filters": [
          {
            "type": "relation",
            "value": "sold"
          }
        ]
      },
      {
        "units": "KB",
        "values": {
          "max": 251658.23,
          "min": 23068.67,
          "avg": 79691.77,
          "total": 159383.55
        },
        "value": 79691.77
      }
    ]
  }
],
{
  "uuid": "420f3462-ca50-fedf-aa8f-223bd39b1852",
  "displayName": "shai-redhat",
  "className": "VirtualMachine",
  "environmentType": "ONPREM",
  "stats": [
    {
      "displayName": "shai-redhat",
      "date": "2019-04-19T00:00:00-04:00",
      "statistics": [
        {
          "name": "VMem",
          "capacity": {
            "max": 1048576,
            "min": 1048576,
            "avg": 1048576,
            "total": 2097152
          },
          "relatedEntityType": "VirtualMachine",
          "filters": [
            {
              "type": "relation",

```

```

        "value": "sold"
      }
    ],
    "units": "KB",
    "values": {
      "max": 20971.52,
      "min": 0,
      "avg": 1048.58,
      "total": 2097.15
    },
    "value": 1048.58
  }
}
...
]
}
]

```

Complex Statistic Queries

Using the POST /stats request, you can retrieve a variety of statistics. For example, this is a complex query made by the Turbonomic UI:

```

{
  "statistics": [
    {
      "name": "CPU",
      "relatedEntityType": "PhysicalMachine",
      "groupBy": [
        "key",
        "virtualDisk"
      ],
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ]
    },
    {
      "name": "Mem",
      "relatedEntityType": "PhysicalMachine",
      "groupBy": [
        "key",
        "virtualDisk"
      ],
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ]
    },
    {
      "name": "NetThroughput",
      "relatedEntityType": "PhysicalMachine",
      "groupBy": [
        "key",
        "virtualDisk"
      ],
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ]
    },
    {
      "name": "IOThroughput",
      "relatedEntityType": "PhysicalMachine",
      "groupBy": [
        "key",
        "virtualDisk"
      ],
      "filters": [
        {

```



```

    "filters": [
      {
        "type": "relation",
        "value": "sold"
      }
    ]
  },
  {
    "name": "Ballooning",
    "relatedEntityType": "PhysicalMachine",
    "groupBy": [
      "key",
      "virtualDisk"
    ],
    "filters": [
      {
        "type": "relation",
        "value": "sold"
      }
    ]
  },
  {
    "name": "Swapping",
    "relatedEntityType": "PhysicalMachine",
    "groupBy": [
      "key",
      "virtualDisk"
    ],
    "filters": [
      {
        "type": "relation",
        "value": "sold"
      }
    ]
  },
  {
    "name": "CPUProvisioned",
    "relatedEntityType": "PhysicalMachine",
    "groupBy": [
      "key",
      "virtualDisk"
    ],
    "filters": [
      {
        "type": "relation",
        "value": "sold"
      }
    ]
  },
  {
    "name": "MemProvisioned",
    "relatedEntityType": "PhysicalMachine",
    "groupBy": [
      "key",
      "virtualDisk"
    ],
    "filters": [
      {
        "type": "relation",
        "value": "sold"
      }
    ]
  },
  {
    "name": "Flow",
    "relatedEntityType": "PhysicalMachine",
    "groupBy": [
      "key",
      "virtualDisk"
    ],
    "filters": [
      {
        "type": "relation",
        "value": "sold"
      }
    ]
  },
  {
    "name": "FlowAllocation",
    "relatedEntityType": "PhysicalMachine",
    "groupBy": [
      "key",

```

```

        "virtualDisk"
      ],
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ]
    },
    {
      "name": "Cooling",
      "relatedEntityType": "PhysicalMachine",
      "groupBy": [
        "key",
        "virtualDisk"
      ],
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ]
    },
    {
      "name": "Power",
      "relatedEntityType": "PhysicalMachine",
      "groupBy": [
        "key",
        "virtualDisk"
      ],
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ]
    },
    {
      "name": "Space",
      "relatedEntityType": "PhysicalMachine",
      "groupBy": [
        "key",
        "virtualDisk"
      ],
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ]
    }
  ]
}

```

The previous request is made in context of a datacenter scope, so the response includes information for each host within that datacenter. The `virtualDisk` value for the `groupBy` parameter ensures that all virtual disks appear in the response as individual line items, rather than an aggregation.

Additionally, the `"filters": [{ "type": "relation", "value": "sold" }]` found throughout the call indicates that the response includes those commodities *sold* by these hosts, rather than purchased from a lower level in the supply chain.

Supplychains Endpoint

Turbonomic models your environment as a market of buyers and sellers. It discovers different types of entities in your environment via the targets you have configured for your installation. Discovery maps these entities to the supply chain so Turbonomic can monitor them and manage the workloads they support. For example, for a hypervisor target Turbonomic discovers VMs, the hosts and datastores that provide resources to the VMs, and the applications that use VM resources. The entities in your environment form a chain of supply and demand where some entities provide resources while others consume the supplied resources.

Using the supplychains endpoint, you can:

- Get a full or filtered supply chain related to an entity in your environment
- Get the statistics for the supply chain related to an entity in your environment

Supplychains Requests

Getting a Supply Chain for the Specified Entity

Gets the full supply chain for the specified entity. For example, if the UUID of a virtual machine is used, you will see the applications that are hosted by that virtual machine, the hosts and datastores that it consumes from, the cluster or datacenter that the hosts consume from, the disk arrays and storage controllers that the datastores consume from, and so on.

In a supply chain, depth refers to the distance in the supply chain from the entity called. For example, if the UUID of a host is used, virtual machines consuming from that host will have a depth of -1, applications consuming from those virtual machines will have a depth of -2, other hosts that are in the supply chain will have a depth of 0, and the cluster of the host will have a depth of 1.

Example: GET [https://10.10.10.10/api/v3/supplychains?](https://10.10.10.10/api/v3/supplychains?uuids=Virtual_ESX_4238042f-7465-e92a-5c28-a7a929307247&health=false)

`uuids=Virtual_ESX_4238042f-7465-e92a-5c28-a7a929307247&health=false`

Response: A `SupplychainApiDTO` representing the supply chain of the specified entity- in this case, a host. Note that when there is a single instance of an entity, Turbonomic will return the details of that entity. In the response, you can see this with the `DPOD` and `Storage Controller` entities.

```
{
  "seMap": {
    "Application": {
      "depth": -2,
      "entitiesCount": 12,
      "stateSummary": {
        "ACTIVE": 5,
        "SUSPEND": 1,
        "IDLE": 6
      }
    },
    "DPOD": {
      "depth": -1,
      "entitiesCount": 1,
      "stateSummary": {
        "ACTIVE": 1
      }
    },
    "instances": {
      "c15cef94af07fccf19e303884592a4ef211764f1": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/c15cef94af07fccf19e303884592a4ef211764f1?include_aspects=false"
          }
        ],
        "uuid": "c15cef94af07fccf19e303884592a4ef211764f1",
        "displayName": "DPOD-data-mycorp",
        "className": "DPOD",
        "priceIndex": 1e-12,
        "state": "ACTIVE",
        "severity": "Normal",
        "environmentType": "ONPREM"
      }
    }
  },
  "...": {
    "StorageController": {
      "depth": 3,
      "entitiesCount": 1,
      "stateSummary": {
        "ACTIVE": 1
      }
    },
    "instances": {
      "be89058c-e786-11e4-82ba-dfc30ffeb3ee": {
        "links": [
          {
            "rel": "self",
            "href": "https://10.10.10.10/api/v3/entities/be89058c-e786-11e4-82ba-dfc30ffeb3ee?include_aspects=false"
          }
        ],
        "uuid": "be89058c-e786-11e4-82ba-dfc30ffeb3ee",
        "displayName": "Storage Controller",
        "className": "StorageController",
        "priceIndex": 1e-12,
        "state": "ACTIVE",
        "severity": "Normal",
        "environmentType": "ONPREM"
      }
    }
  }
}
```

```

        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/be89058c-e786-11e4-82ba-dfc30ffeb3ee?
include_aspects=false"
      }
    ],
    "uuid": "be89058c-e786-11e4-82ba-dfc30ffeb3ee",
    "displayName": "dataontap-mycorp-cm1",
    "className": "StorageController",
    "priceIndex": 20000,
    "state": "ACTIVE",
    "severity": "Normal",
    "discoveredBy": {
      "uuid": "_adGLMJwFEei_xJ5Ai6-rnQ",
      "displayName": "data-cluster.eng.mycorp.com",
      "type": "NetApp"
    },
    "remoteId": "be89058c-e786-11e4-82ba-dfc30ffeb3ee",
    "environmentType": "ONPREM"
  }
}
}
}
}
}

```

Getting Statistics for a Supply Chain

Gets a list of statistics filtered by a user-created SupplyChainStatsApiInputDTO. For more information about the criteria that make up the input for this request, see the Swagger documentation for this request, located at https://<Your_Turbonomic_IP>/swagger/external/index.html.

Example: POST <https://10.10.168.102/api/v3/supplychains/stats>

Example Input: This input will return the number of applications running on the specified UUID (in this case, a Datacenter):

```

{
  "uuids": [
    "e27e5c2f85d91107ac3f26fd63d4478e808f590b"
  ],
  "types": [
    "Application"
  ],
  "environmentType": "ONPREM"
}

```

Response: A list of StatSnapshotApiDTOs representing the filtered statistics for the entity:

```

[
  {
    "date": "2019-05-01T17:45:42-04:00",
    "statistics": [
      {
        "name": "entities",
        "filters": [],
        "value": 25
      }
    ]
  }
]

```

Tags Endpoint

Tags Overview

Tags are metadata attached to resources that you can use to organize your environment. Tags are most often used to delineate resource groupings for technical, automation, business, or security purposes.

Turbonomic discovers tags for AWS, Azure, and vCenter resources.

Using the tags endpoint, you can:

- Get a list of available tags
- Get the members belonging to a specified tag

Additionally, you can use the tags-related requests in the entities endpoint to:

- Assign a tag to an entity
- Delete all tags or a single tag associated to an entity

Tags Requests

Pagination for Tags Requests

When you request tag data, the API uses pagination to return subsets of the data. You should always use pagination when available to make sure you get your data in manageable chunks. To paginate returned data, the `limit`, `orderBy`, and `cursor` parameters control how the APIs paginate their data. If you do not specify a `limit` for the following requests, the API will paginate the data to a default limit of records:

- GET `/tags`
- GET `/tags/<tagKey>/entities`

If your scripts make these requests without setting a limit, you should be sure they check for a pagination cursor in the returned data.

For general information about pagination, see [Pagination in the Turbonomic API](#).

Getting Tags

For a list of tags, the API returns a list of TagApiDTOs. Each TagApiDTO will contain the key/value pair of the tag. The key can be used to see the entities belonging to the tag.

Example: `https://10.10.10.10/api/v3/tags`

Response:

```
[
  {
    "key": "owner",
    "values": [
      "QA_Azure"
    ]
  },
  {
    "key": "director",
    "values": [
      "p-bosh",
      "bosh-init"
    ]
  },
  ...
]
```

Filtering Tags by Scope, Entity, and Environment

Gets a filtered list of tags for the specified scope, entity type, and/or environment. For example, you can use this to find tags only in a particular cluster, tags that affect at least one VM, and/or limit your result to only cloud entities. This request accepts the following parameters:

scopes

A list of UUIDs representing the scope of the request. For example, providing `Market` as a scope will search the entire real-time market. If you provide the UUID of a host, only entities on that host would be in the response.

entity_type

- BUSINESS_UNIT
- CLOUD_SERVICE
- CONTAINER
- DATABASE
- DATABASE_SERVER
- DATACENTER
- DISK_ARRAY
- PHYSICAL_MACHINE
- STORAGE
- VIRTUAL_MACHINE
- SWITCH
- VIRTUAL_DATACENTER
- CHASSIS
- STORAGE_CONTROLLER
- IO_MODULE
- APPLICATION_SERVER
- VIRTUAL_APPLICATION
- NETWORK
- APPLICATION
- CONTAINER
- CONTAINER_POD
- LOGICAL_POOL
- DPOD
- VPOD
- LOAD_BALANCER

environment_type

Returns only tags from entities in the specified environment type. [Cloud, Hybrid, Onprem]

Example: GET [https://10.10.10.10/api/v3/tags?](https://10.10.10.10/api/v3/tags?scopes=Market&entity_type=VirtualMachine&environment_type=ONPREM)

`scopes=Market&entity_type=VirtualMachine&environment_type=ONPREM`

Response: a list of VMs running on-premises in the real-time market with tags.

Getting Entities For A Specified Tag

Referenced Endpoint: [Entities](#)

Gets a list of entities that have the specified tag. An entity is any device in your environment that Turbonomic manages, such as applications, physical machines, VMs, storage, and datacenters.. You can use this information to see where entities with the specified tag are located, what other tags are associated to those entities, and detailed information about each entity.

Example: GET <https://10.10.10.10/api/v3/tags/owner/entities>

Response: A list of entities that have the tag owner:

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/
azure::VM::375ddfb4-3127-44eb-9088-3c7645212f81?include_aspects=false"
```

```

    },
    "uuid": "azure::VM::375ddfb4-3127-44eb-9088-3c7645212f81",
    "displayName": "oleg-westus2-unmanaged-std",
    "className": "VirtualMachine",
    "priceIndex": 3.2109845,
    "state": "ACTIVE",
    "severity": "Normal",
    "costPrice": 0.024,
    "discoveredBy": {
      "uuid": "_GLpj4JwIEei_xJ5Ai6-rnQ",
      "displayName": "mycorp.management.core.windows.net",
      "type": "Azure"
    },
    "remoteId": "azure::VM::375ddfb4-3127-44eb-9088-3c7645212f81",
    "template": {
      "uuid": "azure::VMPROFILE::Basic_A0",
      "displayName": "Basic_A0",
      "discovered": false
    },
    "environmentType": "CLOUD",
    "tags": {
      "owner": [
        "PT_Azure"
      ],
      "AutoSuspend": [
        "false"
      ]
    }
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/azure::VM::c94e96bf-975e-47da-8c52-7ac90161cc87?include_aspects=false"
      }
    ],
    "uuid": "azure::VM::c94e96bf-975e-47da-8c52-7ac90161cc87",
    "displayName": "oleg-westus2-managed-avail-set-1",
    "className": "VirtualMachine",
    "priceIndex": 2.446491,
    "state": "ACTIVE",
    "severity": "Normal",
    "costPrice": 0.018,
    "discoveredBy": {
      "uuid": "_GLpj4JwIEei_xJ5Ai6-rnQ",
      "displayName": "mycorp.management.core.windows.net",
      "type": "Azure"
    },
    "remoteId": "azure::VM::c94e96bf-975e-47da-8c52-7ac90161cc87",
    "template": {
      "uuid": "azure::VMPROFILE::Standard_B1s",
      "displayName": "Standard_B1s",
      "discovered": false
    },
    "environmentType": "CLOUD",
    "tags": {
      "owner": [
        "PT_Azure"
      ],
      "AutoSuspend": [
        "false"
      ]
    }
  }
]

```

Targets Endpoint

A target is a service that performs management functions in your virtual environment. Turbonomic uses targets to monitor workload and to execute actions in your environment.

To discover entities in your environment, you add different targets to your Turbonomic installation. Turbonomic then uses these targets to collect data from your environment.

Turbonomic uses probes to connect to targets and discover their entities. The Turbonomic GUI provides forms for users to specify different target instances. Note that each probe may require different settings, and it's possible that different versions of Turbonomic supports different sets of probes.

For complete target information, review the Turbonomic Target Configuration Guide. You should not modify targets without a full understanding of how they interact with Turbonomic.

Using the targets endpoint of the Turbonomic API, you can:

- Get a single target or list of targets present in your environment
- Get a list of probes available in your Turbonomic installation
- Get the actions or statistics for a target
- Get the workflows discovered by a target
- Add or edit a target
- Trigger validation or rediscovery on a target
- Delete a target

Targets Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble input DTOs, or see the potential values of a particular DTO.

The targets endpoint contains a utility request called specs that shows the information required for probe registry for each target available to Turbonomic, including required input fields and expected target type and category values.

Note:

For a list of probes available to your specific Turbonomic installation, review your organization's licensing agreement.

Example: GET <https://10.10.10.10/api/v3/targets/specs>

Response: An array of TargetApiDTO objects, where each object contains an array of input fields. This example shows one entry for the JVM probe in the Application Server category.

```
[
  {
    [
      ...
      {
        "category": "Application Server",
        "identifyingFields": [
          "nameOrAddress"
        ],
        "inputFields": [
          {
            "displayName": "Scope/Address",
            "name": "nameOrAddress",
            "isMandatory": true,
            "isSecret": false,
            "valueType": "GROUP_SCOPE",
            "description": "The group of VMs or the address of the JVM server"
          },
          {
            "displayName": "Port Number",
            "name": "targetPort",
            "defaultValue": "1099",
            "isMandatory": true,
            "isSecret": false,
            "valueType": "NUMERIC",
            "description": "The JMX port that connects with the JVM server"
          },
          {
            "displayName": "Username",
            "name": "username",
            "isMandatory": true,
            "isSecret": false,
            "valueType": "STRING",
            "description": "The JVM server JMX password, enter a space if the server has no
```

```

security"
  },
  {
    "displayName": "Password",
    "name": "password",
    "isMandatory": true,
    "isSecret": true,
    "valueType": "STRING",
    "description": "The JVM server JMX port, enter a space if the server has no security"
  }
],
"type": "JVM"
},
...
}
]

```

Targets Requests

Target requests handle creation, configuration, validation, rediscovery, and deletion of targets on your Turbonomic appliance.

Pagination for Targets Requests

When you request target entities, the API uses pagination to return subsets of the data. You should always use pagination when available to make sure you get your data in manageable chunks. To paginate returned data, the `limit`, `orderBy`, and `cursor` parameters control how the APIs paginate their data.

If you do not specify a limit for the `GET /targets/<targetId>/entities` request, the API will paginate the data to a default limit of records. If your script makes this request without setting a limit, you should be sure it checks for a pagination cursor in the returned data.

For general information about pagination, see [Pagination in the Turbonomic API](#).

Getting Targets

For a list of targets, the API returns an array of `TargetApiDTO` objects. Each `TargetApiDTO` object will contain the validation status, target type and category, and input field names and values. To get a single target, include the UUID of the target in the request.

This request takes the following parameters:

environment_type

Returns only targets in the specified environment type. [Cloud, Hybrid, Onprem]

Examples:

- All Targets: GET `https://10.10.10.10/api/v3/targets`
- Single Target: GET `https://10.10.10.10/api/v3/targets/__xwWYAE33eku7PbzHdETIA`

Response: A single entry in an array of targets. Notice that the password field is secret, so the response does not contain the password value.

```

[
  {
    "uuid": "__xwWYAE33eku7PbzHdETIA",
    "category": "Hypervisor",
    "type": "vCenter",
    "status": "Validated",
    "lastValidated": "2018-06-26T14:25:08-04:00",
    "inputFields": [
      {
        "displayName": "Address",
        "name": "address",
        "value": "vsphere-demo.mycorp.com",
        "isMandatory": true,
        "isSecret": false,
        "valueType": "STRING",
        "description": "IP or address of vCenter Server",

```

```

        "verificationRegex": ".*"
      },
      {
        "displayName": "Username",
        "name": "username",
        "value": "corp\\my.user",
        "isMandatory": true,
        "isSecret": false,
        "valueType": "STRING",
        "description": "User name to use to connect to a target",
        "verificationRegex": ".*"
      },
      {
        "displayName": "Password",
        "name": "password",
        "isMandatory": true,
        "isSecret": true,
        "valueType": "STRING",
        "description": "Password to use to connect to a target",
        "verificationRegex": ".*"
      }
    ]
  }
}

```

Adding a Target

Adds a target to your Turbonomic installation. You must pass a completed TargetApiDTO object as an inputDTO. For more information about the required fields of the TargetApiDTO for the target you want to add, execute the /targets/specs utility request.

Example: POST https://10.10.10.10/api/v3/targets

Example inputDTO:

```

{
  "category": "Hypervisor",
  "inputFields": [
    {
      "name": "username",
      "value": "corp\\my.name"
    },
    {
      "name": "password",
      "value": "Octopath"
    },
    {
      "name": "nameOrAddress",
      "value": "10.10.10.10"
    }
  ],
  "type": "vCenter"
}

```

Rediscover or Validate All Targets

Manually triggers a full rediscovery or validation of all targets in your environment. This is often done to immediately see multiple changes that would normally not be reflected until a daily full discovery is performed, such as displaying updated Orchestrator workflows.

This call takes the following parameters:

validate

When true, validates all targets in your environment

rediscover

When true, performs a full rediscovery on all targets in your environment

Examples:

- Rediscovery:

POST https://10.10.10.10/api/v3/targets?validate=true

- Validation:

POST https://10.10.10.10/api/v3/targets?rediscover=true

Rediscover or Validate A Single Target

Manually triggers a full rediscovery or validation of a single target in your environment. This is often done to immediately see a change that would normally not be reflected until a daily full discovery is performed, such as displaying updated Orchestrator workflows.

This call takes the following parameters:

validate

When true, validates the specified target

rediscover

When true, performs a full rediscovery on the specified target

Examples:

- Rediscovery: https://10.10.10.10/api/v3/targets/__xwWYAE33eku7PbzHdETIA?rediscover=true
- Validation: https://10.10.10.10/api/v3/targets/__xwWYAE33eku7PbzHdETIA?validate=true

Response: The TargetApiDTO object of the specified target:

```
{
  "uuid": "__xwWYAE33eku7PbzHdETIA",
  "category": "Hypervisor",
  "inputFields": [
    ...
  ],
  "lastValidated": "2018-06-27T21:45:56-04:00",
  "status": "Validated",
  "type": "vCenter"
}
```

Editing Target Input Fields

Edits the input fields of an existing target, and accepts the modified TargetApiDTO as input.

Note: You can GET the target first using the GET /targets/specs to see the fields required for that target. Note that you must pass all input fields in the modified TargetApiDTO object.

Example: PUT https://10.10.10.10/api/v3/targets/_HgZQ4CdCEeaUWYEyo3vsyw

Example input, editing the username for a single target:

```
[
  {
    "uuid": "_HgZQ4CdCEeaUWYEyo3vsyw",
    "category": "Hypervisor",
    "type": "vCenter",
    "status": "Validated",
    "lastValidated": "1474575346109",
    "inputFields": [
      {
        "displayName": "Address",
        "name": "address",
        "value": "vsphere.mycorp.com",
        "isMandatory": true,
        "isSecret": false,
        "valueType": "STRING"
      },
      {
        "displayName": "Username",
        "name": "username",
        "value": "corp\\my.name.changed",
        "isMandatory": true,

```

```

        "isSecret":false,
        "valueType":"STRING"
      },
      {
        "displayName":"Password",
        "name":"password",
        "value":"Octopath",
        "isMandatory":true,
        "isSecret":true
      }
    ]
  }
}
]

```

Deleting a Target

Deletes the specified target and removes all entities managed by that target. This will also remove any pending actions related to the deleted target.

Example: DELETE https://10.10.10.10/api/v3/targets/__xwWYAE3EeiNKPbzHdETIA

Response: A successful deletion request returns a Response Code of 200.

Actions For a Specified Target

Referenced Endpoint: [Actions](#)

These requests get full or filtered lists of actions per target for use in reports, or to find a particular action.

Note: Once you have the action UUID, you can use requests from the actions endpoint to post changes to that action.

Getting an Unfiltered Array of Actions

Gets a list of current actions in your environment associated to entities discovered by the specified target.

Example: GET https://10.10.10.10/api/v3/targets/__xwWYAE3EeiNKPbzHdETIA/actions

Getting a Filtered Array of Actions

Gets a filtered list of actions discovered by a single target. Pass an inputDTO containing one or more of the following criteria:

actionModeList

- **DISABLED:**
Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.
- **RECOMMENDED:**
Recommend the action so a user can execute it via the given hypervisor or by other external means
- **MANUAL:**
Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.
- **AUTOMATED:**
You have directed Turbonomic to execute the action automatically.
- **COLLECTION (UNUSED):**
Legacy action mode, no longer used.

actionStateList

- **DISABLED:**
An action whose policy has been disabled.

- **RECOMMEND:**
An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.
- **PENDING_ACCEPT:**
When the action mode is set to manual, a recommended action that has not been accepted or cleared.
- **ACCEPTED:**
An action that has been accepted, but is not yet in progress.
- **IN_PROGRESS:**
An action that is being executed.
- **SUCCEEDED:**
An action that was accepted and completed successfully.
- **FAILED:**
An action that was accepted and did not complete successfully.
- **REJECTED:**
When the action mode is set to manual, an action that has been rejected by the user.
- **CLEARED:**
When the action mode is set to manual, an action that is no longer recommended by the market.
- **ACCOUNTING:**
For cloud entities, an action to resize in order to use a different instance template.
- **QUEUED:**
When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

actionTypeList

- **START:**
Start an entity, and add it to the Turbonomic market.
- **MOVE:**
Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.
- **SUSPEND:**
Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.
- **ADD_PROVIDER:**
This is equivalent to the START action, but for storage entities.
- **CHANGE:**
Move a virtual machine's storage between datastores.
- **PROVISION:**
Add capacity to your environment.
- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

cleared

Default: `false`.

When `true`, actions that were removed from the action list before being executed will be returned.

costType

- **Saving**

An action that will decrease cloud spending.

- **Investment**

An action that will increase cloud spending.

cumulative

Default: `false`.

When `true`, shows the savings for each action in a scope as a cumulative total, rather than showing the savings for individual actions.

environmentType

- **ONPREM:**

Returns only actions related to entities that are part of your on-premises environment.

- **CLOUD:**

Returns only actions related to entities that are part of your cloud environment.

groupBy

You may group the actions returned by the following criteria: `[actionModes, actionStates, actionTypes, risk, riskSeverity, riskSubCategory]`

hasReservedInstance

Default: `false`.

When `true`, only actions that are related to reserved instances will be returned.

relatedEntityTypes

Returns only actions related to entities of these types within the scope. For example, if your scope is a virtual datacenter and you specify `VirtualMachine` as a related entity type, the request will include only those actions related to VMs in the specified virtual datacenter.

Choose from the following entity types: [Datacenter, PhysicalMachine, VirtualMachine, Storage, Application, Chassis, DiskArray, IOModule, StorageControl, Switch, VirtualDataCenter, VPod, DPod, Container, Database, DatabaseServerContainer, LogicalPool]

riskSeverityList

Returns only actions of the given severities: [Unknown, Normal, Minor, Major, Critical]

riskSubCategoryList

returns only actions of the given subcategories: [Performance Assurance, Efficiency Improvement, Prevention, Compliance]

Example: POST https://10.10.10.10/api/v3/targets/__xwWYAE3EeiNKPbzHdETIA/actions

Example inputDto, filtering for actions that are pending acceptance:

```
{
  "actionStateList":[
    "PENDING_ACCEPT"
  ]
}
```

Response: An array of actions applicable to the specified target that are in the PENDING_ACCEPT state.

```
[
  {
    "links":[
      {
        "rel":"self",
        "href":"https://10.10.10.10/api/v3/actions/_uictIJuHEeics6ASgJ-kdg"
      },
      {
        "rel":"self",
        "href":"https://10.10.10.10/api/v3/actions/2204259249360"
      }
    ],
    "uuid":"_uictIJuHEeics6ASgJ-kdg",
    "createTime":"2018-08-08T23:53:08-04:00",
    "actionType":"RIGHT_SIZE",
    "actionState":"PENDING_ACCEPT",
    "actionMode":"MANUAL",
    "details":"Scale down VMem for VirtualMachine btc-1 from 8 GB to 7 GB",
    "importance":0,
    "target":{
      "uuid":"4223dcd6-0b28-6ae6-1066-689912ced3a1",
      "displayName":"btc-1",
      "className":"VirtualMachine",
      "aspects":{
        "virtualMachineAspect":{
          "os":"Other Linux (64-bit)",
          "connectedNetworks":[
            {
              "uuid":"74c91ba4fa390030f47f91e6e1ee77ff7b4db353",
              "displayName":"VM Network"
            }
          ]
        },
        "numVCPUs":1,
        "ebsOptimized":false
      }
    },
    "environmentType":"ONPREM"
  },
  "currentEntity":{
    "uuid":"_ui4yAZuHEeics6ASgJ-kdg",
    "className":"VMem"
  },
  "newEntity":{
    "uuid":"_ui4yA5uHEeics6ASgJ-kdg",
    "className":"VMem"
  },
  "currentValue":"8388608.0",
  "newValue":"7340032.0",
  "resizeToValue":"7340032.0",
  "risk":{

```

```

    "uuid": "_ujB78ZuHEeics6ASgJ-kdg",
    "subCategory": "Efficiency Improvement",
    "description": "Underutilized VMem in Virtual Machine 'btc-1'",
    "severity": "MINOR",
    "reasonCommodity": "VMem",
    "importance": 0
  },
  "stats": [
    {
      "name": "costPrice",
      "filters": [
        {
          "type": "savingsType",
          "value": "savings"
        }
      ],
      "units": "$",
      "value": 50
    }
  ],
  "actionID": 2204259249360
},
...
]

```

Entities For a Specified Target

Referenced Endpoint: [Entities](#)

Gets a list of entities discovered by the specified target. This is used most often for reporting, dashboard, or inventory purposes.

Getting An Array of Entities

Gets a list of all entities discovered by the specified target. An entity is any device in your environment that Turbonomic manages, such as applications, physical machines, VMs, storage, and datacenters.

Example: GET https://10.10.10.10/api/v3/targets/__xwWYAE3EeiNKPbzHdETIA/actions

Response: An array of EntityApiDTO objects belonging to a vCenter target:

```

[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/vsphere-mycorp.com-ResourcePool-resgroup-8?include_aspects=false"
      }
    ],
    "uuid": "vsphere-mycorp.com-ResourcePool-resgroup-8",
    "displayName": "Resources-Cluster1",
    "className": "VirtualDataCenter",
    "priceIndex": 1e-12,
    "state": "ACTIVE",
    "severity": "Normal",
    "discoveredBy": {
      "uuid": "__xwWYAE3EeiNKPbzHdETIA",
      "displayName": "vsphere-mycorp.com",
      "type": "vCenter"
    },
    "remoteId": "resgroup-8",
    "environmentType": "ONPREM"
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/entities/vsphere-mycorp.com-GuestLoad-421ddc94-8d0c-504a-62f5-493802e96d0a?include_aspects=false"
      }
    ],
    "uuid": "vsphere-mycorp.com-GuestLoad-421ddc94-8d0c-504a-62f5-493802e96d0a",
    "displayName": "GuestLoad[Nexus1000V]",
    "className": "Application",
  }
]

```

```

    "priceIndex":1,
    "state":"ACTIVE",
    "severity":"Normal",
    "discoveredBy":{"
      "uuid":"__xwWYAE3EeiNKPbzHdETIA",
      "displayName":"vsphere-mycorp.com",
      "type":"vCenter"
    },
    "remoteId":"vm-51",
    "environmentType":"ONPREM"
  },
  ...
}
]

```

Templates Endpoint

Turbonomic uses templates to reserve resources and deploy workload in your environment, to calculate supply or demand changes in a plan, and to calculate workloads for cloud environments.

Using the templates endpoint, you can:

- Get a list of templates available to your Turbonomic appliance
- Get information needed to create templates, such as supported OSes and CPUs
- Create a template
- Edit and Delete templates

Templates Utility Requests

Utility requests provide metadata that you can use to make related requests, assemble inputDTOs, or see the potential values of a particular DTO.

The templates endpoint contains utility requests that show the possible values for several optional fields used to create detailed templates. These can be used to find the supported cloud OSes and CPU models.

Getting a List of CPU Models

Gets a list of valid CPU Models. If given a CPU Model, Turbonomic can more accurately reflect your CPU capacity in market decisions.

Example: GET <https://10.10.10.10/api/v3/templates/physicalmachine/cpumodels>

Result: A list of CpuModelApiDTOs, describing the cores, speed, and internal scaling factor for each CPU. This information will be used to provide more granular CPU data, if passed as part of a TemplateApiInputDTO:

```

[
  {
    "numCores": 4,
    "speed": 3500,
    "scalingFactor": 1.116909571123129,
    "modelName": "AMD A10 PRO-7800B"
  },
  {
    "numCores": 4,
    "speed": 3700,
    "scalingFactor": 0.9745581799084503,
    "modelName": "AMD A10 PRO-7850B"
  },
  ...
  {
    "numCores": 8,
    "speed": 1415,
    "scalingFactor": 1.1638948014750774,
    "modelName": "UltraSPARC T2 Plus"
  }
]

```

Templates Requests

Template requests handle creation, configuration, editing and deletion of templates on your Turbonomic appliance.

Getting a List of Templates

Gets a list of templates available to your Turbonomic instance. This list will include both templates discovered from underlying targets and those created through the Turbonomic UI. To get a specific template, pass the template UUID as part of the request.

Examples:

- All Templates: GET <https://10.10.10.10/api/v3/templates>
- Single Target: GET https://10.10.10.10/api/v3/templates/_v0Q70MpiEd-hypXfJzX8Wg

Response: A list of TemplateApiDTOs:

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/templates/_v0Q70MpiEd-hypXfJzX8Wg"
      }
    ],
    "uuid": "_v0Q70MpiEd-hypXfJzX8Wg",
    "displayName": "Small",
    "className": "PhysicalMachineProfile",
    "price": 5000,
    "computeResources": [
      {
        "stats": [
          {
            "name": "numOfCores",
            "value": 4
          },
          {
            "name": "cpuSpeed",
            "units": "MHz",
            "value": 2992
          },
          {
            "name": "ioThroughputSize",
            "units": "MB/s",
            "value": 890
          },
          {
            "name": "memorySize",
            "units": "MB",
            "value": 32759
          },
          {
            "name": "networkThroughputSize",
            "units": "MB/s",
            "value": 512
          }
        ]
      }
    ],
    "infrastructureResources": [
      {
        "stats": [
          {
            "name": "powerSize",
            "value": 1
          },
          {
            "name": "spaceSize",
            "value": 1
          },
          {
            "name": "coolingSize",
            "value": 1
          }
        ]
      }
    ]
  }
]
```



```

    ],
    "discovered": false
  },
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/templates/_v0Q70cpiEd-hypXfJzX8Wg"
      }
    ],
    "uuid": "_v0Q70cpiEd-hypXfJzX8Wg",
    "displayName": "Medium",
    "className": "PhysicalMachineProfile",
    "price": 10000,
    "computeResources": [
      {
        "stats": [
          {
            "name": "numOfCores",
            "value": 4
          },
          {
            "name": "cpuSpeed",
            "units": "MHz",
            "value": 2992
          },
          {
            "name": "ioThroughputSize",
            "units": "MB/s",
            "value": 1780
          },
          {
            "name": "memorySize",
            "units": "MB",
            "value": 65519
          },
          {
            "name": "networkThroughputSize",
            "units": "MB/s",
            "value": 512
          }
        ]
      }
    ],
    "infrastructureResources": [
      {
        "stats": [
          {
            "name": "powerSize",
            "value": 1
          },
          {
            "name": "spaceSize",
            "value": 1
          },
          {
            "name": "coolingSize",
            "value": 1
          }
        ]
      }
    ],
    "discovered": false
  },
  ...
]

```

Creating a Template

Creates a template for use in your environment. You must pass a completed `TemplateApiInputDTO` as the inputDTO. You can create templates for virtual machines, physical machines, storage, and containers.

Example: POST <https://10.10.10.10/api/v3/templates>

Example inputs:

Container

```
{
  "computeResources": [
    {
      "stats": [
        {
          "name": "ioThroughput",
          "value": 0
        },
        {
          "name": "networkThroughput",
          "value": 0
        },
        {
          "name": "memorySize",
          "value": 8192
        },
        {
          "name": "cpuSpeed",
          "value": 1536
        }
      ]
    }
  ],
  "storageResources": [
    {
      "stats": [
        {
          "name": "diskSize",
          "value": 20
        }
      ]
    }
  ],
  "className": "ContainerProfile",
  "displayName": "ContainerTemplate1"
}
```

Physical Machine

```
{
  "cpuModel": "AMD A10-5700",
  "computeResources": [
    {
      "stats": [
        {
          "name": "ioThroughputSize",
          "value": 1000
        },
        {
          "name": "networkThroughputSize",
          "value": 1000
        },
        {
          "name": "memorySize",
          "value": 8192
        },
        {
          "name": "numOfCores",
          "value": 4
        },
        {
          "name": "cpuSpeed",
          "value": "3400"
        }
      ]
    }
  ],
  "price": 0,
  "className": "PhysicalMachineProfile",
  "displayName": "HostTemplate1"
}
```

Storage

```
{
  "storageResources": [
    {
      "stats": [
        {
          "name": "diskIops",
          "value": 250
        },
        {
          "name": "diskSize",
          "value": 750
        }
      ]
    }
  ],
  "price": 0,
  "className": "StorageProfile",
  "displayName": "StorageTemplate1"
}
```

Virtual Machine

```
{
  "computeResources": [
    {
      "stats": [
        {
          "name": "ioThroughput",
          "value": 0
        },
        {
          "name": "networkThroughput",
          "value": 500
        },
        {
          "name": "memorySize",
          "value": 4096
        },
        {
          "name": "memoryConsumedFactor",
          "value": 70
        },
        {
          "name": "numOfCpu",
          "value": 2
        },
        {
          "name": "cpuSpeed",
          "value": 1024
        },
        {
          "name": "cpuConsumedFactor",
          "value": 75
        }
      ]
    }
  ],
  "storageResources": [
    {
      "type": "disk",
      "stats": [
        {
          "name": "diskIops",
          "value": 50
        },
        {
          "name": "diskSize",
          "value": 20
        },
        {
          "name": "diskConsumedFactor",
          "value": 70
        }
      ]
    }
  ]
}
```

```
]
}
```

Response: The TemplateApiInputDTO for the template created. In this case, a virtual machine template:

```
{
  "uuid": "_lmaQoLUtEei5nORDMStFGA",
  "displayName": "VirtualMachineTemplate1",
  "className": "VirtualMachineProfile",
  "computeResources": [
    {
      "stats": [
        {
          "name": "numOfCpu",
          "value": 2.0
        },
        {
          "name": "cpuSpeed",
          "units": "MHz",
          "value": 1024.0
        },
        {
          "name": "cpuConsumedFactor",
          "units": "%",
          "value": 75.0
        },
        {
          "name": "memorySize",
          "units": "MB",
          "value": 4096.0
        },
        {
          "name": "memoryConsumedFactor",
          "units": "%",
          "value": 70.0
        },
        {
          "name": "ioThroughput",
          "units": "MB/s",
          "value": 0.0
        },
        {
          "name": "networkThroughput",
          "units": "MB/s",
          "value": 500.0
        }
      ]
    }
  ],
  "storageResources": [
    {
      "stats": [
        {
          "name": "diskIops",
          "value": 50.0
        },
        {
          "name": "diskSize",
          "units": "GB",
          "value": 20.0
        },
        {
          "name": "diskConsumedFactor",
          "units": "%",
          "value": 70.0
        }
      ]
    },
    {
      "type": "disk"
    }
  ],
  "deploymentProfile": {
    "uuid": "_1lbZMrUtEei5nORDMStFGA",
    "displayName": "VirtualMachineTemplate1_DeploymentProfile",
    "className": "ServiceCatalogItem",
    "deployParameters": [
      {
        "targetType": "vCenter",
        "providers": [
```

```

    {
      "provider": {
        "uuid": "dfe657268310d8b128d441b2a34ec0721e72ee7e",
        "displayName": "Development DC7",
        "className": "DataCenter",
        "discoveredBy": {
          "uuid": "_0jF3UJwFEei_xJ5Ai6-rnQ",
          "displayName": "vsphere-dc7.mycorp.com",
          "type": "vCenter"
        }
      },
      "parameters": [
        {
          "parameterType": "image",
          "properties": [
            {
              "name": "id",
              "value": "path/to/image"
            }
          ]
        }
      ]
    }
  ],
  "discovered": false
}

```

Editing a Template

Edits a user-created template, given the template UUID and the edited DTO. To edit discovered templates, edit them on the target from which they originate. Note that you must pass a complete TemplateApiDTO with the edited fields.

Example: PUT https://10.10.10.10/api/v3/templates/_lmaQoLUtEei5nORDMStFGA

Example input: Note that both the displayName and diskConsumedFactor values were changed:

```

{
  "computeResources": [
    {
      "stats": [
        {
          "name": "ioThroughput",
          "value": 0
        },
        {
          "name": "networkThroughput",
          "value": 500
        },
        {
          "name": "memorySize",
          "value": 4096
        },
        {
          "name": "memoryConsumedFactor",
          "value": 70
        },
        {
          "name": "numOfCpu",
          "value": 2
        },
        {
          "name": "cpuSpeed",
          "value": 1024
        },
        {
          "name": "cpuConsumedFactor",
          "value": 75
        }
      ]
    }
  ],
  "storageResources": [
    {

```

```

        "type": "disk",
        "stats": [
            {
                "name": "diskIops",
                "value": 50
            },
            {
                "name": "diskSize",
                "value": 20
            },
            {
                "name": "diskConsumedFactor",
                "value": 75
            }
        ]
    },
    {
        "className": "VirtualMachineProfile",
        "displayName": "VirtualMachineTemplate1_Modified",
        "deploymentProfileId": "_1lbZMrUtEei5nORDMStFGA"
    }
]
}

```

Response: The modified TemplateApiDTO reflecting the submitted changes.

Deleting a Template

Deletes the specified template. This will not delete associated deployment profiles, and deployments already scheduled to use this template will not succeed.

Example: DELETE https://10.10.10.10/api/v3/templates/_1maQoLUtEei5nORDMStFGA

Response: A successful deletion will return true.

Topology Definitions Endpoint

Turbonomic gives you the ability to create your own Business Applications, Business Transactions, and Services without the need to ingest additional application data into the Turbonomic platform. This is especially useful in cases where there are gaps in the application stack shown in the Turbonomic supply chain. For example, in the absence of an application monitoring target such as AppDynamics or Dynatrace, you will not see Business Applications in your supply chain. This feature addresses those gaps.

When you create a new application entity, you identify interrelated application entities and nodes in your existing environment for which you want to measure performance, so Turbonomic can link them in a supply chain and represent them as a unified group. You can monitor overall performance for the group in the context of the new application entity, and drill down to the individual entities and nodes for finer details.

Using the topology definitions endpoint of the Turbonomic API, you can:

- Get a single topology definition or list of topology definitions present in your environment
- Create a topology definition
- Edit a topology definition
- Delete a topology definition

Topology Definition Requests

Topology definition requests handle creation, configuration, editing, and deletion of topology definitions on your Turbonomic appliance.

Getting Topology Definitions

For a list of topology definitions, the API returns an array of TopologyDataDefinitionApiDTO. Each TopologyDataDefinitionApiDTO will contain the UUID, entity type, and connection attributes for the defined topology. To get a single topology definition, include the UUID of the topology definition in the request.

Examples:

- All Topology Definitions: GET <https://10.10.10.10/api/v3/topologydefinitions>
- Single Topology Definition: GET <https://10.10.10.10/api/v3/topologydefinitions/284711321829968>

Response:

```
{
  "uuid": "284711313871856",
  "displayName": "Daltest1__App",
  "entityType": "BusinessApplication",
  "entityDefinitionData": {
    "namePrefix": "Daltest1_",
    "entityType": "VirtualMachine",
    "generationAndConnectionAttribute": {
      "expVal": "App",
      "expType": "EQ",
      "filterType": "virtualMachinesByTag",
      "caseSensitive": true,
      "entityType": null,
      "singleLine": false
    }
  }
}
```

Creating a Manual Topology Definition

To create a manual topology definition, you must provide the `entityType` of the definition, and manual mapping data to the entities to use. Consider the following input DTO to create a manual topology definition:

```
{
  "entityType": "BusinessApplication",
  "entityDefinitionData": {
    "manualConnectionData": {
      "BusinessTransaction": {
        "staticConnections": [
          "73585155548499",
          "73585155548500"
        ]
      },
      "Service": {
        "staticConnections": [
          "73585155548487",
          "73585155608929"
        ]
      },
      "ApplicationComponent": {
        "staticConnections": [
          "73596151905427",
          "73596151905425",
          "73596151905428",
          "73596151905429"
        ]
      },
      "VirtualMachine": {
        "staticConnections": [
          "73586657216608",
          "73585300874097",
          "73586657216576"
        ]
      },
      "DatabaseServer": {
        "staticConnections": [
          "73585314633044",
          "73585314632869",
          "73585314632946"
        ]
      },
      "Container": {
        "staticConnections": [
          "73585323455544",
          "73582124234229",
          "73585385438946"
        ]
      }
    }
  }
}
```

```

    ]
  },
  "ContainerPod": {
    "staticConnections": [
      "73585334243044",
      "73585314324535",
      "73585314533256"
    ]
  }
}
},
"displayName": "DalManualtest_"
}

```

In the `manualConnectionData` parameter of the `entityDefinitionData`, the UUIDs of the related entities have been provided for each level of the supply chain for which the topology should be instantiated.

The creation can be as simple or complex as desired. For example, a simple manual topology may look like the following:

```

{
  "entityType": "BusinessTransaction",
  "entityDefinitionData": {
    "manualConnectionData": {
      "Service": {
        "staticConnections": [
          "73585155548487"
        ]
      },
      "Container": {
        "staticConnections": [
          "73596151905298"
        ]
      }
    }
  },
  "uuid": "284711514573216",
  "displayName": "DalManualSimple"
}

```

Creating an Automated Topology Definition

To create an automated topology definition, you must provide the `entityType` of the definition, and the data that makes up the regular expression used to determine dynamic group membership. Consider the following input DTO to create an automated topology definition:

```

{
  "entityType": "BusinessApplication",
  "entityDefinitionData": {
    "entityType": "VirtualMachine",
    "namePrefix": "Daltest1_",
    "generationAndConnectionAttribute": {
      "expType": "EQ",
      "expVal": "App",
      "filterType": "vmsByTag",
      "caseSensitive": false
    }
  }
}

```

In the `generationAndConnectionAttribute` parameter of the `entityDefinitionData`, the information that makes up the regular expression is sent. In this instance, it will match any virtual machine whose tag value equals "App".

Editing a Topology Definition

Edits the input fields of an existing topology definition, and accepts the modified `TopologyDataDefinitionApiDTO` as input.

Note: You can GET the topology definition first using the GET /topologydefinition/UUID request to see the current configuration. Note that you must pass all fields in the modified TopologyDataDefinitionApiDTO, not only the changed fields.

A successful edit will return the modified TopologyDataDefinitionApiDTO.

Example: PUT https://10.10.10.10/api/v3/topologydefinitions

Deleting a Topology Definition

Deletes the specified topology definition and removes all created entities. This will also remove any pending actions related to the deleted entities.

Example: DELETE https://10.10.10.10/api/v3/topologydefinitions/284711321829968

Response: A successful deletion request returns a Response Code of 200.

Workflows Endpoint

When added to your Turbonomic installation, Orchestrator targets assign workflows that execute multiple actions to make changes in your environment. Turbonomic discovers workflows that you have defined on the orchestrator. You can then set up an automation policy that maps workflows to actions. If the action mode is Manual or Automatic, then when Turbonomic recommends the action, it will direct the orchestrator to use the mapped workflow to execute it.

For more information about specific Orchestrator targets, see the Target Configuration Guide. For more information about execution of workflows, see the User Guide.

Using the workflows endpoint, you can:

- Get a list of all workflows
- Get detailed information about a specified workflow

Workflows Requests

Getting Workflows

For a list of workflows, the API returns an array of WorkflowApiDTOs. Each WorkflowApiDTO object will contain detailed information about that workflow, including description and parameters. To get a single workflow, include the UUID of the workflow in the request.

This call takes the following parameter:

type

Filters the request by type of workflow. [UCSD, AWS_Service_Catalog]

Examples:

- All Workflows: GET https://10.10.10.10/api/v3/workflows
- Single Workflow: GET https://10.10.10.10/api/v3/workflows/UCSD-WF-ucsd.eng.mycorp.com-103

Response:

```
[
  {
    "links": [
      {
        "rel": "self",
        "href": "https://10.10.10.10/api/v3/workflows/UCSD-WF-ucsd.eng.mycorp.com-103"
      }
    ],
    "uuid": "UCSD-WF-ucsd.eng.mycorp.com-103",
    "displayName": "APIC Container Delete Firewall Rule Action",
    "className": "Workflow",
    "actionType": "NONE",
    "parameters": [

```

```

    {
      "name": "APIC_TENANT_L4L7_EPG_ACE_IDENTITY",
      "isMandatory": true,
      "isSecret": false,
      "specificValueType": "ApicTenantL4L7EPGAceIdentity"
    },
    {
      "name": "L4L7Identity",
      "isMandatory": true,
      "isSecret": false,
      "specificValueType": "gen_text_input"
    },
    {
      "name": "ACLName",
      "isMandatory": true,
      "isSecret": false,
      "specificValueType": "gen_text_input"
    },
    {
      "name": "ACENAME",
      "isMandatory": true,
      "isSecret": false,
      "specificValueType": "gen_text_input"
    }
  ],
  "discoveredBy": {
    "uuid": "U1MIJv-Eei_xJ5Ai6-rnQ",
    "displayName": "ucsd.eng.mycorp.com",
    "type": "Cisco UCS Director"
  }
},
...
]

```

Getting Workflows of a Specific Type

By adding the type parameter to the `/api/v3/workflows` request, you can filter workflows from a specific source. For example, the response to this request will be an array of `WorkflowApiDTOs` discovered through UCS Director targets:

Example: GET `https://10.10.10.10/api/v3/workflows?type=UCSD`

Turbonomic Cookbook

Purpose

The Turbonomic cookbook is intended to assist in performing specific tasks using the API, and answering commonly-asked questions while presenting Turbonomic API best practices. This section of the API Guide is a living document, meaning that it is constantly being added to.

If there is a situation or task you would like to see included, please send an email to Dallas.DeMarr@turbonomic.com describing the task, and the desired result.

Cookbooks

Each cookbook contains one or more recipes. Each recipe will contain all the necessary information to complete the specified task, along with a basic script showing the functionality of the recipe.

- [Authenticating with the Turbonomic API](#)
- [Plan Results Cookbook](#)
 - [Seeing Changes to a Subset of Entities](#)

Authenticating With the API

Objective

To obtain an authentication token after logging in with the API, and use that token on subsequent API calls.

Authentication in the API

To use the API, you must have a valid user account on the Turbonomic instance. Also note that accounts can have different roles. The API will only execute commands that are valid for your user role. For example, to execute Turbonomic recommended actions, your account must have a role of either administrator, deployer, or automator.

To make API calls, you create an authentication token and pass it with each subsequent request to the Turbonomic API. A common way to do this is to store the cookie locally.

Example: `curl -s -k -c /tmp/cookies -H 'accept: application/json' 'https://localhost/api/v3/login?hateoas=true' -d 'username=administrator&password=password'`

Then, each request must use the `-b cookie-filename` parameter to use the session cookie delivered by the login request.

Prerequisites

In order to obtain an authentication token, you must have the following information:

- The username and password of the user who will be logged in.

Procedure

To obtain an authentication token:

1. Construct the API payload.

The input body should be JSON, in the following format with your credentials in place of `myUsername` and `myPassword`:

```
{'username': 'myUsername', 'password': 'myPassword'}
```

2. Make the API request.

Use the `POST https://[INSTANCE_IP]/api/v3/login` request, with the input body constructed in the previous step.

3. Retrieve the authentication token from the response headers.

Example headers:

```
{
  'Server': 'nginx',
  'Date': 'Mon, 01 Feb 2021 20:17:02 GMT',
  'Content-Type': 'application/json',
  'Transfer-Encoding': 'chunked',
  'Connection': 'keep-alive',
  'Vary': 'Accept-Encoding',
  'Set-Cookie': 'JSESSIONID=node0jzerbqte09pe1j29x6ypo92fh17.node0; Path=/; HTTPOnly; Secure',
  'Expires': 'Thu, 01 Jan 1970 00:00:00 GMT',
  'X-Content-Type-Options': 'nosniff',
  'X-XSS-Protection': '1; mode=block',
  'Strict-Transport-Security': 'max-age=63072000; includeSubDomains',
  'X-Frame-Options': 'SAMEORIGIN',
  'X-Turbo-Upstream': 'API',
  'Content-Encoding': 'gzip'
}
```

```
}
```

The authentication token is the value of the Set-Cookie header before the ;. In this case, JSESSIONID=node0jzerbqte09pe1j29x6ypo92fh17.node0.

Using the Authentication Token in Subsequent API Requests

Once you have obtained an authentication token, you can use that token to make further API requests. To do so, include a header in your request with the name of cookie and a value of the token. For example:

```
{'cookie': 'JSESSIONID=node0jzerbqte09pe1j29x6ypo92fh17.node0' }
```

Script Example

The following script obtains and stores an authentication token.

ip

The IP address of the Turbonomic instance

username

The username of the account to be logged in

password

the password of the account to be logged in

```
import requests
import urllib3
urllib3.disable_warnings()

ip = '10.10.170.153'
username = 'administrator'
password = 'administrator'

payload = {'username': username, 'password': password}
r = requests.post(f'https://{ip}/vmturbo/rest/login', data=payload, verify=False)
r.encoding = 'JSON'
token = r.headers['Set-Cookie'].split(';')[0]
print(token)
```

Script Result

The result of this script displays the authentication token:

```
JSESSIONID=node0jzerbqte09pe1j29x6ypo92fh17.node0
```

Plan Results Cookbook

This cookbook explores plan markets in Turbonomic. Interpreting and parsing this plan market will enable you to better understand how and why Turbonomic has performed a certain action on a particular entity, how the resources- both used and available- have changed, and more as recipes are added to the cookbook.

Note: The Turbonomic UI has certain plan configuration options, available to present a base set of configuration changes to accomplish a particular goal. For example, the Add Workload plan is preconfigured to expect additional workloads to be provisioned. To see how Turbonomic creates these configurations, view the DTOs for the UI plan configurations at [Scenario Examples](#).

Related Endpoints

When interpreting plan results, the following endpoints are commonly used to retrieve and clarify data:

- **Actions:** Retrieving the actions for the plan market will enable you to see what entities were directly affected during the run of the plan.
- **Entities:** Retrieving the entities for the plan market will enable you to see a full listing of the entities involved in the plan.
- **Groups:** Retrieving the groups for the plan market will enable you to more easily obtain UUID information for the entities in the specified group.
- **Statistics:** Retrieving the market statistics for the plan market as a whole, a group, or an entity will enable you to easily see a broad overview of the state of the entity utilization after the plan has finished.

Use Case Index

The Plan Results Cookbook has the following recipes:

- [Seeing Changes to a Subset of Entities](#)

Seeing Changes to a Subset of Entities

Objective

After running a plan, you may want to see the effects of your plan on a particular entity or group of entities in order to better understand the effect your configuration changes had on a subset of plan entities, or to explore the reason Turbonomic made a specific decision.

For example, assume that there is a virtual machine with high internal visibility. Separate from the overall plan results, there is interest in what the plan did to this VM in particular.

Prerequisites

In order to investigate the changes to the specified entity, you must have the following information:

- The UUID of a successfully completed plan market

To obtain this UUID, either get it from the API response sent when you POST a scenario to the market, or execute the GET `/markets` request, and find the market whose name corresponds with the name of the scenario. Alternately, the UUID of the scenario can be found in the `scenario` parameter of the plan market. Verify that the `state` parameter has a value of `SUCCEEDED`. For example, the UUID of the scenario that created the following plan market is 214410933912976, and the UUID of the plan market itself is 214410933923968:

```
{
  "uuid": "214410933923968",
  "displayName": "Optimize Cloud 2",
  "className": "Market",
  "state": "SUCCEEDED",
  "stateProgress": 100,
  "scenario": {
    "uuid": "214410933912976",
    "displayName": "Optimize Cloud 2",
    ...
  }
  ...
}
```

To verify that you have the correct run of the plan in the event that the scenario has been applied multiple times, also verify that the `runDate` parameter corresponds to the time you expect the plan to have run.

Note: For more information about creating and running scenarios, see the [Scenario DTO Breakdown](#) topic.

- The UUID(s) of the entities for which you want detailed information returned

Note: Plan market entity UUIDs are identical to their real-time market counterparts, meaning that the UUIDs can be retrieved either from searching the plan market for a related field (for example, the `displayName` of the entity) or utilizing the Turbonomic UI to find the entity and retrieve the UUID.

Related Endpoints

When interpreting plan results, the following endpoints are commonly used to retrieve and clarify data:

- **Actions:** Retrieving the actions for the plan market will enable you to see what entities were directly affected during the run of the plan.
- **Entities:** Retrieving the entities for the plan market will enable you to see a full listing of the entities involved in the plan.
- **Groups:** Retrieving the groups for the plan market will enable you to more easily obtain UUID information for the entities in the specified group.
- **Statistics:** Retrieving the market statistics for the plan market as a whole, a group, or an entity will enable you to easily see a broad overview of the state of the entity utilization after the plan has finished.

Procedure

To investigate changes to a particular subset of plan entities:

1. Obtain the list of UUIDs that you will investigate. All entity UUIDs can be found through the API call listed below. You can iterate through any other identifying parameter, such as `displayName`, and find the UUID associated to that entity.

API: `markets/{market_uuid}/entities` executed against the plan or real-time market.

2. Obtain the list of plan actions.

API: `GET /markets/{market_Uuid}/actions` executed against the plan market. You may also choose to utilize the `POST /markets/{market_uuid}/actions` request with a filter for advanced action queries, such as only returning actions of a particular type, or particular risk severity.

3. Search the API response and find the action(s) relevant to your entities.

Each action will have a `target` parameter, which will in turn have a `uuid` parameter. This UUID is the UUID of the entity upon which the action was executed, and is the best practice solution for locating your entity in a list of actions.

If no actions have the specified `target > uuid` value, then no actions were performed on the entity in question.

Note: You can use the `GET /markets/{market_Uuid}/entities` request to verify that the UUID you are searching for exists in the plan market. If it does not, it means that the entity was not included in the scope of the plan, or the entity is considered an idle workload. For more information about idle workloads, see the *Idle Workloads* topic in the Turbonomic User Guide.

API: None.

4. Analyze the results.

Each action contains the information detailed in the [ActionApiDTO DTO Reference](#), including the details of the action, old/new values for any changed resources, a record of deletion for DELETE actions, etc.

Search through this DTO and make note of any parameters important to you.

API: None.

5. Create the Script.

Each action contains a plethora of information, detailed in the [ActionApiDTO DTO Reference](#), including the details of the action, old/new values for any changed resources, a record of deletion for DELETE actions, etc.

API: None.

Script: (Results)

```
Plan Changes for Entity(ies):
73556963039649

uuid - 144042191234304
vm_uuid - 73556963039649
actionType - SCALE
actionState - SUCCEEDED
details - Scale Virtual Machine PT_Resize_Down_Target from m5a.2xlarge to m5a.xlarge
currentEntity.displayName - m5a.2xlarge
newEntity.displayName - m5a.xlarge
template.uuid - 73556963039778
risk.subCategory - Efficiency Improvement
risk.description - Underutilized VCPU, Net Throughput, IO Throughput, VMem
currentLocation.displayName - aws-Canada (Central)
newLocation.displayName - aws-Canada (Central)
```

Script Example

The following script searches through the list of actions for a virtual machine, and returns the requested fields for quick comparison. In this case, the UUID, type, state, reason, risk category, and risk subcategory are returned for the action, and paired with the display name, template UUID, and location of the entity.

This script is easily extensible- for example, if `currentLocation > displayName` is equal to `newLocation > displayName`, you may choose not to show either of those fields, as no change involving the VM location was made. You might also use these results to make further calls- for example, using the template UUID to make a GET `/templates/{template_Uuid}` request to return more information about the template being used for a resize action.

```
using System;
using System.Collections.Generic;
using System.IO;
using System.Linq;
using Newtonsoft.Json.Linq;

namespace EntityChanges
{
    internal static class Program
    {
        //The UUIDs whose actions I want returned.//
        private static readonly List<string> ValuesToFind = new List<string>
        {
            "73556963039649"
        };

        //The parameters whose values I want returned.//
        private static readonly List<string> RetrieveFields = new List<string>
        {
            "uuid",
            "actionType",
            "actionState",
            "details",
            "currentEntity.displayName",
            "newEntity.displayName",
            "template.uuid",
            "risk.subCategory",
            "risk.description",
            "currentLocation.displayName",
            "newLocation.displayName"
        };

        //A list of JToken objects to be parsed.//
        private static readonly List<JToken> Results = new List<JToken>();
```

```

public static void Main(string[] args)
{
    //In this case, I have saved the results of the //
    //GET /markets/{market_uuid}/actions of the plan market to a file. //
    //You can also ingest the result of an API call directly. //
    JObject allJson = JObject.Parse(File.ReadAllText("plan_actions.json"));

    //This captures the entire actionApiDTO related to the entity. //
    string valueDescription = ValuesToFind.Aggregate(string.Empty,
        (current, value) => current + (value + "\n"));
    Console.WriteLine("Plan Changes for Entity(ies):\n" + valueDescription);

    //For each action in the plan actions
    foreach (JToken jsonObject in allJson.Root.Children())
    {
        //Get the uuid parameter nested in the target parameter //
        string objectValue = GetValueFromPath(jsonObject, "target.uuid");

        //If it matches any of the UUIDs we are looking for //
        if (ValuesToFind.Any(objectValue.Contains))
        {
            //Add the action to our array of actions. //
            Results.Add(jsonObject);
        }
    }

    //For each action in the result set //
    foreach (JToken jsonObject in Results)
    {
        //For each wanted parameter
        foreach (string retrieve in RetrieveFields)
        {
            //Write the parameter name and parameter value to the //
            //console. //
            Console.WriteLine(retrieve + " - " +
                GetValueFromPath(jsonObject, retrieve));
        }

        Console.WriteLine("-----");
    }
}

//This is the way I choose to traverse JSON, using periods to denote //
//levels- any number of methods will work for this functionality, //
//including third-party JSON libraries. //
private static string GetValueFromPath(JToken jsonObject, string path)
{
    if (path.Contains("."))
    {
        string[] pathExploded = path.Split('.');

        string value = String.Empty;

        switch (pathExploded.Length)
        {
            case 2:
                value = jsonObject[pathExploded[0]]?
                    .Value<string>(pathExploded[1]);
                break;

            case 3:
                value = jsonObject[pathExploded[0]]
                    ?.Value<JToken>(pathExploded[1])
                    .Value<string>(pathExploded[2]);
                break;

            case 4:
                value = jsonObject[pathExploded[0]]
                    ?.Value<JToken>(pathExploded[1])
                    .Value<JToken>(pathExploded[2])
                    .Value<string>(pathExploded[3]);
                break;

            case 5:
                value = jsonObject[pathExploded[0]]
                    ?.Value<JToken>(pathExploded[1])
                    .Value<JToken>(pathExploded[2])
                    .Value<JToken>(pathExploded[3])
                    .Value<string>(pathExploded[4]);
                break;
        }
    }
}

```



```

        return value;
    }

    return jsonObject.Value<string>(path);
}
}
}
}

```

Script Result

The result of this script displays the requested information for each plan entity:

```

Plan Changes for Entity(ies):
73556963039649

uuid - 144042191234304
vm_uuid - 73556963039649
actionType - SCALE
actionState - SUCCEEDED
details - Scale Virtual Machine PT_Resize_Down_Target from m5a.2xlarge to m5a.xlarge
currentEntity.displayName - m5a.2xlarge
newEntity.displayName - m5a.xlarge
template.uuid - 73556963039778
risk.subCategory - Efficiency Improvement
risk.description - Underutilized VCPU, Net Throughput, IO Throughput, VMem
currentLocation.displayName - aws-Canada (Central)
newLocation.displayName - aws-Canada (Central)

```

Seeing the Changes for a Group of Entities

You can easily modify this script to see the changes for a particular group of entities without needing to know each UUID.

To perform this modification, consume the result of a GET `/groups/{group_uuid}/entities` request. Example result:

```

[
  {
    "uuid": "73422419372894",
    "displayName": "PT_RHEL",
    "className": "VirtualMachine",
    "priceIndex": 4.33,
    "state": "ACTIVE",
    "severity": "Normal",
    "costPrice": 0.24104111,
    "discoveredBy": {
      "uuid": "73422416392368",
      "displayName": "producttrust",
      "category": "Public Cloud",
      "type": "AWS",
      "readonly": false
    },
  },
  ...
],
[
  {
    "uuid": "73422419372988",
    "displayName": "PT_Resize_Up_Target",
    "className": "VirtualMachine",
    "priceIndex": 10074.822,
    "state": "ACTIVE",
    "severity": "Normal",
    "costPrice": 0.078387,
    "discoveredBy": {
      "uuid": "73422416392368",
      "displayName": "producttrust",
      "category": "Public Cloud",
      "type": "AWS",
      "readonly": false
    },
  },
  ...
]

```

```

    },
    {
      "uuid": "73422419372921",
      "displayName": "PT_Consistent_Scaling_VM_1",
      "className": "VirtualMachine",
      "priceIndex": 100.357,
      "state": "ACTIVE",
      "severity": "Normal",
      "costPrice": 0.0159137,
      "discoveredBy": {
        "uuid": "73422416392368",
        "displayName": "producttrust",
        "category": "Public Cloud",
        "type": "AWS",
        "readonly": false
      },
    },
    ...
  }
]

```

Using this result, you can either use each UUID found, or filter based on entities. For example, to iterate through a group and get the UUID of all VM entities:

```

foreach (var entity in groupApiResponse)
{
  if (entity["className"] == VirtualMachine)
  {
    Console.WriteLine(entity["uuid"])
  }
}

```

Appendix: Internal Turbonomic API Requests

Internal Requests are requests that are used internally by Turbonomic, but are not intended for customer use. The structure data returned by these requests is subject to change without notice.

The following requests have been marked as Internal Only:

/entities

```

DELETE /entities/loggingEntities
PUT /entities/{entity_Uuids}/loggingEntities
GET /entities/{entity_Uuid}/aspects/{aspect_name}/actions
POST /entities/{entity_Uuid}/aspects/{aspect_name}/actions
GET /entities/{entity_Uuid}/aspects/{aspect_name}/stats
POST /entities/{entity_Uuid}/aspects/{aspect_name}/stats
POST /entities/{entity_Uuid}/tags
DELETE /entities/{entity_Uuid}/tags
DELETE /entities/{entity_Uuid}/tags/{tag_key}

```

/groups

```

GET /groups/{group_Uuid}/aspects/{aspect_name}/actions
POST /groups/{group_Uuid}/aspects/{aspect_name}/actions
GET /groups/{group_Uuid}/aspects/{aspect_name}/stats
POST /groups/{group_Uuid}/aspects/{aspect_name}/stats
POST /groups/{group_Uuid}/notifications/stats
POST /groups/{group_Uuid}/tags

```

```
DELETE /groups/{group_Uuid}/tags
DELETE /groups/{group_Uuid}/tags/{tag_key}
```

/markets

```
PUT /markets/{market_Uuid}/policies/{policy_Uuid}
```

/reports

```
POST /reports/templates
```

/scenarios

```
PUT /scenarios/{scenario_Uuid}
PUT /scenarios/{scenario_Uuid}/entities/{entity_Uuid}
DELETE /scenarios/{scenario_Uuid}/entities/{entity_Uuid}
PUT /scenarios/{scenario_Uuid}/groups/{group_Uuid}
PUT /scenarios/{scenario_Uuid}/policies
DELETE /scenarios/{scenario_Uuid}/policies/{policy_Uuid}
PUT /scenarios/{scenario_Uuid}/templates/{template_name}
```

/widgetsets

The entire /widgetsets endpoint is Internal Only.

Appendix: Scenario Peak-of-Peak Full Scenario Input DTO

For reference purposes, see below for a complete input DTO for a Peak of Peaks plan.

```
{
  "uuid": "XXXXDemo",
  "displayName": "XXXXDemo",
  "owners": [
    {
      "uuid": "_4T_7kwY-Ed-WUKbEYSVIDw",
      "username": "administrator",
      "showSharedUserSC": false
    }
  ],
  "type": "PEAKOFPEAKS",
  "scope": [
    {
      "uuid": "_PE0v-YEUEee_hYfzgV9uYg",
      "displayName": "All On-prem Hosts",
      "className": "All On-prem Hosts"
    }
  ],
  "topologyChanges": {
  },
  "loadChanges": {
    "maxUtilizationList": [
      {
        "maxPercentage": 70,
        "projectionDay": 0,
        "target": {
          "displayName": "All On-prem Hosts",
          "className": "Group",
          "uuid": "_PE0v-YEUEee_hYfzgV9uYg"
        }
      }
    ]
  },
  "overlayStatsList": [
    {
      "uuid": "4223ae0c-c99b-f6ca-c1ef-3f367bdf5528",
      "displayName": "centos_imp_2",
      "className": "VirtualMachine",
      "environmentType": "ONPREM",
      "stats": [

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{
  "displayName": "centos_imp_2",
  "date": "2019-02-01T00:00:00-05:00",
  "statistics": [
    {
      "displayName": "centos_imp_2",
      "date": "2019-03-14T15:12:36-04:00",
      "statistics": [
        {
          "name": "priceIndex",
          "values": {
            "max": 20000,
            "min": 20000,
            "avg": 20000,
            "total": 20000
          },
          "value": 20000
        },
        {
          "name": "CPUProvisioned",
          "capacity": {
            "max": 104000,
            "min": 104000,
            "avg": 104000,
            "total": 104000
          },
          "filters": [
            {
              "type": "relation",
              "value": "bought"
            }
          ],
          "relatedEntity": {
            "uuid": "Virtual_ESX_4238255f-86cc-4cb9-0f47-11ff689f0b22",
            "displayName": "hp-esx4.dev.mycorp.com",
            "className": "PhysicalMachine"
          },
          "units": "MHz",
          "values": {
            "max": 5200,
            "min": 5200,
            "avg": 5200,
            "total": 5200
          },
          "value": 5200
        },
        {
          "name": "Mem",
          "capacity": {
            "max": 16776692,
            "min": 16776692,
            "avg": 16776692,
            "total": 16776692
          },
          "filters": [
            {
              "type": "relation",
              "value": "bought"
            }
          ],
          "relatedEntity": {
            "uuid": "Virtual_ESX_4238255f-86cc-4cb9-0f47-11ff689f0b22",
            "displayName": "hp-esx4.dev.mycorp.com",
            "className": "PhysicalMachine"
          },
          "units": "KB",
          "values": {
            "max": 3555836,
            "min": 3554799.8,
            "avg": 3554799.8,
            "total": 3554799.8
          },
          "value": 3554799.8
        },
        {
          "name": "MemProvisioned",
          "capacity": {
            "max": 167766912,
            "min": 167766912,
            "avg": 167766912,
            "total": 167766912
          }
        }
      ]
    }
  ]
}

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    "filters":[
      {
        "type":"relation",
        "value":"bought"
      }
    ],
    "relatedEntity":{
      "uuid":"Virtual_ESX_4238255f-86cc-4cb9-0f47-11ff689f0b22",
      "displayName":"hp-esx4.dev.mycorp.com",
      "className":"PhysicalMachine"
    },
    "units":"KB",
    "values":{
      "max":4194304,
      "min":4194304,
      "avg":4194304,
      "total":4194304
    },
    "value":4194304
  },
  {
    "name":"StorageAmount",
    "capacity":{
      "max":3301375,
      "min":3301375,
      "avg":3301375,
      "total":3301375
    },
    "filters":[
      {
        "type":"relation",
        "value":"bought"
      }
    ],
    "relatedEntity":{
      "uuid":"6f76b47e-e6f0a3fe",
      "displayName":"QSGRID01:ESXDC1DS1",
      "className":"Storage"
    },
    "units":"MB",
    "values":{
      "max":725.32,
      "min":725.32,
      "avg":725.32,
      "total":725.32
    },
    "value":725.32
  },
  {
    "name":"NetThroughput",
    "capacity":{
      "max":3072000,
      "min":3072000,
      "avg":3072000,
      "total":3072000
    },
    "filters":[
      {
        "type":"relation",
        "value":"bought"
      }
    ],
    "relatedEntity":{
      "uuid":"Virtual_ESX_4238255f-86cc-4cb9-0f47-11ff689f0b22",
      "displayName":"hp-esx4.dev.mycorp.com",
      "className":"PhysicalMachine"
    },
    "units":"Kbit/sec",
    "values":{
      "max":0,
      "min":0,
      "avg":0,
      "total":0
    },
    "value":0
  },
  {
    "name":"MemAllocation",
    "capacity":{
      "max":52503552,
      "min":52503552,
      "avg":52503552,

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        "total":52503552
    },
    "filters":[
        {
            "type":"key",
            "value":"VirtualDataCenter::2332ba0f9dc14c07f11adb38e12df43c4bc8ca56"
        },
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"2332ba0f9dc14c07f11adb38e12df43c4bc8ca56",
        "displayName":"olga_do_not_touch_1",
        "className":"VirtualDataCenter"
    },
    "units":"KB",
    "values":{
        "max":3555836,
        "min":3554799.8,
        "avg":3554799.8,
        "total":3554799.8
    },
    "value":3554799.8
},
{
    "name":"VCPU",
    "capacity":{
        "max":5200,
        "min":5200,
        "avg":5200,
        "total":5200
    },
    "filters":[
        {
            "type":"relation",
            "value":"sold"
        }
    ],
    "units":"MHz",
    "values":{
        "max":5214,
        "min":5201.9,
        "avg":5201.9,
        "total":5201.9
    },
    "value":5201.9
},
{
    "name":"Ballooning",
    "capacity":{
        "max":16776692,
        "min":16776692,
        "avg":16776692,
        "total":16776692
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"Virtual_ESX_4238255f-86cc-4cb9-0f47-11ff689f0b22",
        "displayName":"hp-esx4.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "units":"KB",
    "values":{
        "max":0,
        "min":0,
        "avg":0,
        "total":0
    },
    "value":0
},
{
    "name":"StorageAccess",
    "capacity":{
        "max":5000,
        "min":5000,

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        "avg":5000,
        "total":5000
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"6f76b47e-e6f0a3fe",
        "displayName":"QSGRID01:ESXDC1DS1",
        "className":"Storage"
    },
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    "values":{
        "max":0,
        "min":0,
        "avg":0,
        "total":0
    },
    "value":0
},
{
    "name":"CPUAllocation",
    "capacity":{
        "max":31096,
        "min":31096,
        "avg":31096,
        "total":31096
    },
    "filters":[
        {
            "type":"key",
            "value":"VirtualDataCenter::2332ba0f9dc14c07f11adb38e12df43c4bc8ca56"
        },
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"2332ba0f9dc14c07f11adb38e12df43c4bc8ca56",
        "displayName":"olga_do_not_touch_1",
        "className":"VirtualDataCenter"
    },
    "units":"MHz",
    "values":{
        "max":5214,
        "min":5201.9,
        "avg":5201.9,
        "total":5201.9
    },
    "value":5201.9
},
{
    "name":"IOThroughput",
    "capacity":{
        "max":11264000,
        "min":11264000,
        "avg":11264000,
        "total":11264000
    },
    "reserved":{
        "max":9011200,
        "min":9011200,
        "avg":9011200,
        "total":9011200
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"Virtual_ESX_4238255f-86cc-4cb9-0f47-11ff689f0b22",
        "displayName":"hp-esx4.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "units":"Kbit/sec",
    "values":{

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        "max":0,
        "min":0,
        "avg":0,
        "total":0
    },
    "value":0
},
{
    "name":"StorageLatency",
    "capacity":{
        "max":100,
        "min":100,
        "avg":100,
        "total":100
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"6f76b47e-e6f0a3fe",
        "displayName":"QSGRID01:ESXDC1DS1",
        "className":"Storage"
    },
    "units":"msec",
    "values":{
        "max":0.5,
        "min":0.5,
        "avg":0.5,
        "total":0.5
    },
    "value":0.5
},
{
    "name":"VMem",
    "capacity":{
        "max":4194304,
        "min":4194304,
        "avg":4194304,
        "total":4194304
    },
    "filters":[
        {
            "type":"relation",
            "value":"sold"
        }
    ],
    "units":"KB",
    "values":{
        "max":3397384,
        "min":3233807,
        "avg":3233807,
        "total":3233807
    },
    "value":3233807
},
{
    "name":"CPU",
    "capacity":{
        "max":10400,
        "min":10400,
        "avg":10400,
        "total":10400
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"Virtual_ESX_4238255f-86cc-4cb9-0f47-11ff689f0b22",
        "displayName":"hp-esx4.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "units":"MHz",
    "values":{
        "max":5214,
        "min":5201.9,
        "avg":5201.9,

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        "total":5201.9
      },
      "value":5201.9
    },
    {
      "name":"VStorage",
      "capacity":{
        "max":2646,
        "min":1014,
        "avg":2238,
        "total":8952
      },
      "filters":[
        {
          "type":"key",
          "value":"VirtualMachine::08bb59f519b55c22415be8d623b5ccdf578b85cc"
        },
        {
          "type":"relation",
          "value":"sold"
        }
      ],
      "units":"MB",
      "values":{
        "max":1016.14,
        "min":142.4,
        "avg":797.71,
        "total":3190.82
      },
      "value":797.71
    }
  ]
},
{
  "uuid":"4223bb37-0090-f332-0140-cc3cce7b3735",
  "displayName":"centos_imp_3",
  "className":"VirtualMachine",
  "environmentType":"ONPREM",
  "stats":[
    {
      "displayName":"centos_imp_3",
      "date":"2019-02-01T00:00:00-05:00",
      "statistics":[
        {
          "displayName":"centos_imp_3",
          "date":"2019-03-14T15:12:36-04:00",
          "statistics":[
            {
              "name":"priceIndex",
              "values":{
                "max":20000,
                "min":20000,
                "avg":20000,
                "total":20000
              },
              "value":20000
            }
          ],
          "name":"CPUProvisioned",
          "capacity":{
            "max":104000,
            "min":104000,
            "avg":104000,
            "total":104000
          },
          "filters":[
            {
              "type":"relation",
              "value":"bought"
            }
          ],
          "relatedEntity":{
            "uuid":"Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
            "displayName":"hp-esx1.dev.mycorp.com",
            "className":"PhysicalMachine"
          },
          "units":"MHz",
          "values":{
            "max":5200,
            "min":5200,

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        "avg":5200,
        "total":5200
    },
    "value":5200
},
{
    "name":"Swapping",
    "capacity":{
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        "min":40000000,
        "avg":40000000,
        "total":40000000
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
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        "displayName":"hp-esx1.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "units":"bit/sec",
    "values":{
        "max":0,
        "min":0,
        "avg":0,
        "total":0
    },
    "value":0
},
{
    "name":"NumDisk",
    "capacity":{
        "max":2147483650,
        "min":2147483650,
        "avg":2147483650,
        "total":2147483650
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
        "displayName":"hp-esx1.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "values":{
        "max":1,
        "min":1,
        "avg":1,
        "total":1
    },
    "value":1
},
{
    "name":"Mem",
    "capacity":{
        "max":16776692,
        "min":16776692,
        "avg":16776692,
        "total":16776692
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
        "displayName":"hp-esx1.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "units":"KB",
    "values":{
        "max":3069332,

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        "min":3062497,
        "avg":3062497,
        "total":3062497
    },
    "value":3062497
},
{
    "name":"MemProvisioned",
    "capacity":{
        "max":167766912,
        "min":167766912,
        "avg":167766912,
        "total":167766912
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
        "displayName":"hp-esx1.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "units":"KB",
    "values":{
        "max":4194304,
        "min":4194304,
        "avg":4194304,
        "total":4194304
    },
    "value":4194304
},
{
    "name":"StorageAmount",
    "capacity":{
        "max":3301375,
        "min":3301375,
        "avg":3301375,
        "total":3301375
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"6f76b47e-e6f0a3fe",
        "displayName":"QSGRID01:ESXDC1DS1",
        "className":"Storage"
    },
    "units":"MB",
    "values":{
        "max":719,
        "min":719,
        "avg":719,
        "total":719
    },
    "value":719
},
{
    "name":"NetThroughput",
    "capacity":{
        "max":3072000,
        "min":3072000,
        "avg":3072000,
        "total":3072000
    },
    "filters":[
        {
            "type":"relation",
            "value":"bought"
        }
    ],
    "relatedEntity":{
        "uuid":"Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
        "displayName":"hp-esx1.dev.mycorp.com",
        "className":"PhysicalMachine"
    },
    "units":"Kbit/sec",

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      "values":{
        "max":0,
        "min":0,
        "avg":0,
        "total":0
      },
      "value":0
    },
    {
      "name":"MemAllocation",
      "capacity":{
        "max":52503552,
        "min":52503552,
        "avg":52503552,
        "total":52503552
      },
      "filters":[
        {
          "type":"key",
          "value":"VirtualDataCenter::2332ba0f9dc14c07f11adb38e12df43c4bc8ca56"
        },
        {
          "type":"relation",
          "value":"bought"
        }
      ],
      "relatedEntity":{
        "uuid":"2332ba0f9dc14c07f11adb38e12df43c4bc8ca56",
        "displayName":"olga_do_not_touch_1",
        "className":"VirtualDataCenter"
      },
      "units":"KB",
      "values":{
        "max":3069332,
        "min":3062497,
        "avg":3062497,
        "total":3062497
      },
      "value":3062497
    },
    {
      "name":"VCPU",
      "capacity":{
        "max":5200,
        "min":5200,
        "avg":5200,
        "total":5200
      },
      "filters":[
        {
          "type":"relation",
          "value":"sold"
        }
      ],
      "units":"MHz",
      "values":{
        "max":5203,
        "min":5194.67,
        "avg":5194.67,
        "total":5194.67
      },
      "value":5194.67
    },
    {
      "name":"Ballooning",
      "capacity":{
        "max":16776692,
        "min":16776692,
        "avg":16776692,
        "total":16776692
      },
      "filters":[
        {
          "type":"relation",
          "value":"bought"
        }
      ],
      "relatedEntity":{
        "uuid":"Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
        "displayName":"hp-esx1.dev.mycorp.com",
        "className":"PhysicalMachine"
      },
    },
  ],
}

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        "units": "KB",
        "values": {
            "max": 0,
            "min": 0,
            "avg": 0,
            "total": 0
        },
        "value": 0
    },
    {
        "name": "StorageAccess",
        "capacity": {
            "max": 5000,
            "min": 5000,
            "avg": 5000,
            "total": 5000
        },
        "filters": [
            {
                "type": "relation",
                "value": "bought"
            }
        ],
        "relatedEntity": {
            "uuid": "6f76b47e-e6f0a3fe",
            "displayName": "QSGRID01:ESXDC1DS1",
            "className": "Storage"
        },
        "units": "IOPS",
        "values": {
            "max": 0,
            "min": 0,
            "avg": 0,
            "total": 0
        },
        "value": 0
    },
    {
        "name": "CPUAllocation",
        "capacity": {
            "max": 31096,
            "min": 31096,
            "avg": 31096,
            "total": 31096
        },
        "filters": [
            {
                "type": "key",
                "value": "VirtualDataCenter::2332ba0f9dc14c07f11adb38e12df43c4bc8ca56"
            },
            {
                "type": "relation",
                "value": "bought"
            }
        ],
        "relatedEntity": {
            "uuid": "2332ba0f9dc14c07f11adb38e12df43c4bc8ca56",
            "displayName": "olga_do_not_touch_1",
            "className": "VirtualDataCenter"
        },
        "units": "MHz",
        "values": {
            "max": 5203,
            "min": 5194.67,
            "avg": 5194.67,
            "total": 5194.67
        },
        "value": 5194.67
    },
    {
        "name": "IOTthroughput",
        "capacity": {
            "max": 11264000,
            "min": 11264000,
            "avg": 11264000,
            "total": 11264000
        },
        "reserved": {
            "max": 9011200,
            "min": 9011200,
            "avg": 9011200,
            "total": 9011200
        }
    }
]

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    },
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "relatedEntity": {
      "uuid": "Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
      "displayName": "hp-esx1.dev.mycorp.com",
      "className": "PhysicalMachine"
    },
    "units": "Kbit/sec",
    "values": {
      "max": 0,
      "min": 0,
      "avg": 0,
      "total": 0
    },
    "value": 0
  },
  {
    "name": "StorageLatency",
    "capacity": {
      "max": 100,
      "min": 100,
      "avg": 100,
      "total": 100
    },
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "relatedEntity": {
      "uuid": "6f76b47e-e6f0a3fe",
      "displayName": "QSGRID01:ESXDC1DS1",
      "className": "Storage"
    },
    "units": "msec",
    "values": {
      "max": 0.33,
      "min": 0.33,
      "avg": 0.33,
      "total": 0.33
    },
    "value": 0.33
  },
  {
    "name": "Q2VCPU",
    "capacity": {
      "max": 20000,
      "min": 20000,
      "avg": 20000,
      "total": 20000
    },
    "reserved": {
      "max": 10000,
      "min": 10000,
      "avg": 10000,
      "total": 10000
    },
    "filters": [
      {
        "type": "relation",
        "value": "bought"
      }
    ],
    "relatedEntity": {
      "uuid": "Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
      "displayName": "hp-esx1.dev.mycorp.com",
      "className": "PhysicalMachine"
    },
    "units": "msec",
    "values": {
      "max": 11,
      "min": 11,
      "avg": 11,
      "total": 11
    },
    "value": 11
  }
]

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    },
    {
      "name": "VMem",
      "capacity": {
        "max": 4194304,
        "min": 4194304,
        "avg": 4194304,
        "total": 4194304
      },
      "filters": [
        {
          "type": "relation",
          "value": "sold"
        }
      ],
      "units": "KB",
      "values": {
        "max": 2894068,
        "min": 2747267,
        "avg": 2747267,
        "total": 2747267
      },
      "value": 2747267
    },
    {
      "name": "CPU",
      "capacity": {
        "max": 10400,
        "min": 10400,
        "avg": 10400,
        "total": 10400
      },
      "filters": [
        {
          "type": "relation",
          "value": "bought"
        }
      ],
      "relatedEntity": {
        "uuid": "Virtual_ESX_4238a511-8593-4469-2751-46611e09b6a8",
        "displayName": "hp-esx1.dev.mycorp.com",
        "className": "PhysicalMachine"
      },
      "units": "MHz",
      "values": {
        "max": 5203,
        "min": 5194.67,
        "avg": 5194.67,
        "total": 5194.67
      },
      "value": 5194.67
    },
    {
      "name": "VStorage",
      "capacity": {
        "max": 2646,
        "min": 1014,
        "avg": 2238,
        "total": 8952
      },
      "filters": [
        {
          "type": "key",
          "value": "VirtualMachine::199bb3ec4f8da89f01c126a6b3df4c1321c4b07d"
        },
        {
          "type": "relation",
          "value": "sold"
        }
      ],
      "units": "MB",
      "values": {
        "max": 1016.01,
        "min": 142.4,
        "avg": 797.61,
        "total": 3190.42
      },
      "value": 797.61
    }
  ]
}
]

```

```

    }
  ],
  "timebasedTopologyChanges": {
  }
}

```

Appendix: Reference Tables

Reference Tables Overview

This section of the Appendix will contain reference tables for common API parameters, separated by endpoint. Note that filter tables may contain other reference tables for completeness.

Action Reference Tables

Action Mode:

- **DISABLED:**

Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.

- **RECOMMENDED:**

Recommend the action so a user can execute it via the given hypervisor or by other external means

- **MANUAL:**

Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.

- **AUTOMATED:**

You have directed Turbonomic to execute the action automatically.

- **COLLECTION (UNUSED):**

Legacy action mode, no longer used.

Action State:

- **DISABLED:**

An action whose policy has been disabled.

- **RECOMMEND:**

An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.

- **PENDING_ACCEPT:**

When the action mode is set to manual, a recommended action that has not been accepted or cleared.

- **ACCEPTED:**

An action that has been accepted, but is not yet in progress.

- **IN_PROGRESS:**

An action that is being executed.

- **SUCCEEDED:**

An action that was accepted and completed successfully.

- **FAILED:**

An action that was accepted and did not complete successfully.

- **REJECTED:**

When the action mode is set to manual, an action that has been rejected by the user.

- **CLEARED:**

When the action mode is set to manual, an action that is no longer recommended by the market.

- **ACCOUNTING:**

For cloud entities, an action to resize in order to use a different instance template.

- **QUEUED:**

When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

Action Type:

- **START:**

Start an entity, and add it to the Turbonomic market.

- **MOVE:**

Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.

- **SUSPEND:**

Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.

- **ADD PROVIDER:**

This is equivalent to the START action, but for storage entities.

- **CHANGE:**

Move a virtual machine's storage between datastores.

- **PROVISION:**

Add capacity to your environment.

- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

Action Filter Criteria:

actionModeList

- **DISABLED:**
Do not recommend or perform the action. When you disable an action, the user interface will no longer display actions of that type.
- **RECOMMENDED:**
Recommend the action so a user can execute it via the given hypervisor or by other external means
- **MANUAL:**
Recommend the action, and provide the option to execute that action through the Turbonomic user interface or an /actions API request.
- **AUTOMATED:**
You have directed Turbonomic to execute the action automatically.
- **COLLECTION (UNUSED):**
Legacy action mode, no longer used.

actionStateList

- **DISABLED:**
An action whose policy has been disabled.
- **RECOMMEND:**
An action that cannot be automated due to policy settings or must be executed outside the system, such as the purchase of hardware.
- **PENDING_ACCEPT:**
When the action mode is set to manual, a recommended action that has not been accepted or cleared.
- **ACCEPTED:**
An action that has been accepted, but is not yet in progress.
- **IN_PROGRESS:**
An action that is being executed.
- **SUCCEEDED:**
An action that was accepted and completed successfully.
- **FAILED:**
An action that was accepted and did not complete successfully.
- **REJECTED:**
When the action mode is set to manual, an action that has been rejected by the user.
- **CLEARED:**
When the action mode is set to manual, an action that is no longer recommended by the market.
- **ACCOUNTING:**
For cloud entities, an action to resize in order to use a different instance template.
- **QUEUED:**
When more than 10 actions are to be executed for a single target, Turbonomic will place the 11th and all subsequent actions into a QUEUED state, and they will execute as the previous actions complete.

actionTypeList

- **START:**

Start an entity, and add it to the Turbonomic market.

- **MOVE:**

Move an entity from one provider to another. For example, moving a VM between hosts, or a datastore between disk arrays.

- **SUSPEND:**

Suspend the entity to exclude its capacity from your environment. Suspend does not remove the entity from your environment, but the market does not include the entity in its analysis. Based on market conditions, analysis can recommend restarting suspended entities, which includes them in market analysis once again.

- **ADD PROVIDER:**

This is equivalent to the START action, but for storage entities.

- **CHANGE:**

Move a virtual machine's storage between datastores.

- **PROVISION:**

Add capacity to your environment.

- **RECONFIGURE:**

Analysis recommends this when a VM is not able to correct a misconfiguration via another type of action. For example, analysis can recommend a RECONFIGURE action when a placement policy requires a VM to move to a host on a particular cluster, but cross-cluster moves are not permitted.

- **DELETE:**

This is equivalent to the SUSPEND action, but for storage entities.

- **RESERVE_ON_PM:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular host.

- **RESERVE_ON_DS:**

When using the reservation functionality, this is the action to reserve the resources of a VM on a particular datastore.

- **RESIZE_FOR_EFFICIENCY:**

A resize that reduces the capacity of a commodity, such as vCPU, or vMEM.

- **RESIZE_FOR_PERFORMANCE:**

A resize that increases the capacity of a commodity, such as vCPU, or vMEM.

cleared

Default: `false`.

When `true`, actions that were removed from the action list before being executed will be returned.

costType

- **Saving**

An action that will decrease cloud spending.

- **Investment**

An action that will increase cloud spending.

cumulative

Default: `false`.

When `true`, shows the savings for each action in a scope as a cumulative total, rather than showing the savings for individual actions.

environmentType

- ONPREM:

Returns only actions related to entities that are part of your on-premises environment.

- CLOUD:

Returns only actions related to entities that are part of your cloud environment.

groupBy

You may group the actions returned by the following criteria: [actionModes, actionStates, actionTypes, risk, riskSeverity, riskSubCategory]

hasReservedInstance

Default: false.

When true, only actions that are related to reserved instances will be returned.

relatedEntityTypes

Returns only actions related to entities of these types within the scope. For example, if your scope is a virtual datacenter and you specify VirtualMachine as a related entity type, the request will include only those actions related to VMs in the specified virtual datacenter.

Choose from the following entity types: [Datacenter, PhysicalMachine, VirtualMachine, Storage, Application, Chassis, DiskArray, IOModule, StorageControl, Switch, VirtualDataCenter, VPod, DPod, Container, Database, DatabaseServerContainer, LogicalPool]

riskSeverityList

Returns only actions of the given severities: [Unknown, Normal, Minor, Major, Critical]

riskSubCategoryList

returns only actions of the given subcategories: [Performance Assurance, Efficiency Improvement, Prevention, Compliance]

Entity Reference Tables

Entity State:

- ACTIVE:

Entity is actively consuming resources.

- EVACUATED:

Entity is ready to suspend and will not participate in the market, but will not generate a SUSPEND action.

Note: This state replaces the SUSPEND state, and requires additional configuration to enable. Turbonomic does not recommend enabling this state.

- FAILOVER:

This entity is reserved for failover and will not participate in the market.

- IDLE:

Entity is powered off and not actively consuming market resources.

- LAUNCH:

Entity is starting.

- MAINTENANCE:

Entity is in maintenance mode.

- NOT_MONITORED:

Entity is not currently monitored by Turbonomic.

- QUEUED:

Entity is in the process of changing from one state to another.

Note: This state is internal to Turbonomic and will not appear in the UI, but may appear in an API response if the call is executed at the precise moment the entity is changing state.

- RESOURCE_ALLOCATION:

Cloud entity is being created.

- RESOURCE_RELEASE:

Cloud Entity is being deleted.

- SUSPEND:

Entity is suspended or the guest OS is in sleep, standby, or suspended state. The entity is not removed from the environment, but will not be used in market decisions. Based on market conditions, suspended entities can be started, re-adding them to the market.

- SUSPEND_PENDING:

Entity is making preparations to suspend, or is the next entity of its type to suspend.

- TERMINATE_PENDING:

Entity is in the process of being deleted.

- UNKNOWN:

Turbonomic is unable to obtain the current state of the entity.

This occurs when the entity is reported to the hypervisor as having a state of DISCONNECTED, ORPHANED, or INVALID.

Entity Type:

- BUSINESS_UNIT
- CLOUD_SERVICE
- CONTAINER
- DATABASE
- DATABASE_SERVER
- DATACENTER
- DISK_ARRAY
- PHYSICAL_MACHINE
- STORAGE
- VIRTUAL_MACHINE
- SWITCH
- VIRTUAL_DATACENTER
- CHASSIS
- STORAGE_CONTROLLER
- IO_MODULE
- APPLICATION_SERVER
- VIRTUAL_APPLICATION
- NETWORK
- APPLICATION
- CONTAINER
- CONTAINER_POD
- LOGICAL_POOL

- DPOD
- VPOD
- LOAD_BALANCER

Appendix: DTO Index

Data transfer objects (DTOs) are used to encapsulate and send data to the Turbonomic API. The following DTOs are used by Turbonomic:

Note:

The DTO Index is a work in progress, and included in a draft stage for reference. The information contained in the Index is accurate, but may not be complete.

ActionApiDTO

Description

Model to describe an Action

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

actionImpactID

- **type:** integer
- **format:** int64
- **description:** The ID for the action, which will persist across restarts

marketID

- **type:** integer
- **format:** int64
- **description:** The ID of the market for which the action was generated

createTime

- **type:** string
- **description:** Creation time

updateTime

- **type:** string
- **description:** Update time

clearTime

- **type:** string
- **description:** Execution time

actionType

- **type:** string
- **description:** Type
- **enum:** ['START', 'MOVE', 'SCALE', 'ALLOCATE', 'SUSPEND', 'PROVISION', 'RECONFIGURE', 'RESIZE', 'DELETE', 'RIGHT_SIZE', 'BUY_RI']

actionState

- **type:** string
- **description:** Action State
- **enum:** ['PENDING_ACCEPT', 'ACCEPTED', 'REJECTED', 'PRE_IN_PROGRESS', 'POST_IN_PROGRESS', 'IN_PROGRESS', 'SUCCEEDED', 'FAILED', 'RECOMMENDED', 'DISABLED', 'QUEUED', 'CLEARED', 'ACCOUNTING', 'READY', 'FAILING']

actionMode

- **type:** string
- **description:** Action Mode
- **enum:** ['DISABLED', 'RECOMMEND', 'EXTERNAL_APPROVAL', 'MANUAL', 'AUTOMATIC', 'COLLECTION']

userName

- **type:** string
- **description:** Username of the user that accepted the action

details

- **type:** string
- **description:** A user-readable string describing the action

importance

- **type:** number
- **format:** float
- **description:** Numeric value that describes the priority of the action

target

- **description:** Target entity for an action. For example, the VM in a Resize Action, or the host for a VM move
- **ServiceEntityApiDTO**

currentEntity

- **description:** Current entity, such as the current host that a VM resides on for a VM move action
- **ServiceEntityApiDTO**

newEntity

- **description:** Destination entity, such as the host that a VM will move to for a VM move action
- **ServiceEntityApiDTO**

currentValue

- **type:** string
- **description:** Current value of a property, for example vMEM for a VM resize action

newValue

- **type:** string
- **description:** Calculated value to resize to, such as vMEM for a VM resize action

valueUnits

- **type:** string
- **description:** Units of the currentValue and newValue, such as KB for a VM vMEM resize action

resizeAttribute

- **type:** string
- **description:** The commodity attribute to be resized
- **enum:** ['CAPACITY', 'LIMIT', 'RESERVATION']

template

- **description:** Template used for the action, such as in a Cloud entity provision or move action
- **TemplateApiDTO**

risk

- **description:** Cause of the action
- **LogEntryApiDTO**

prerequisites

- **type:** array
- **description:** Description(s) of any prerequisite(s) that must occur before execution is possible. If this field is populated, the action would otherwise be executable but has been blocked by this prerequisite, and is displayed accordingly. If this field is not populated, no prerequisite has caused the action mode to be modified, and the action is displayed as normal.
- – **type:** string

prioritizedAutomationOpportunities

- **type:** array
- **description:** The Action is generated using the 'Prioritize Automation' setting, indicating that it is possible to have more savings if these opportunities are satisfied
- – **type:** string

stats

- **type:** array
- **description:** Statistics, such as Mem, vCPU, costPrice
- – **StatApiDTO**

progress

- **type:** integer
- **format:** int32
- **description:** Moved the 'progress' percentage value inside 'executionStatus', available when action detail level is 'EXECUTION' - [DEPRECATED - Use: executionStatus.progress]

currentLocation

- **description:** The region (DataCenter) where the current service entity is located, for cloud migration actions
- **BaseApiDTO**

newLocation

- **description:** The region, represented as a DataCenter entity, where the target service entity will be located for cloud migration actions
- **BaseApiDTO**

virtualDisks

- **type:** array
- **description:** Virtual Disk used for the action, for example in a storage move
- – [VirtualDiskApiDTO](#)

policy

- **description:** The policy associated with the action
- [PolicyApiDTO](#)

relatedSettingsPolicies

- **type:** array
- **description:** The related settings policies associated with the action
- – [BaseApiDTO](#)

actionSchedule

- **description:** The schedule associated with the action
- [ActionScheduleApiDTO](#)

compoundActions

- **type:** array
- **description:** Property for compound move actions
- – [ActionApiDTO](#)

reservedInstance

- **description:** The Reserved Instance associated with the action
- [ReservedInstanceApiDTO](#)

reservedInstancePlatform

- **type:** string
- **description:** The platform of the recommended RI if the action has a supersaving

externalActionName

- **type:** string
- **description:** The name under which this action appears in third-party software or external approval backend

externalActionUrl

- **type:** string
- **description:** URL to third-party software showing this action. Suitable for external action approval

executionStatus

- **description:** Status details of the execution of the Action. Include percentage progress, error messages and execution times.
- [ActionExecutionAuditApiDTO](#)

executionCharacteristics

- **description:** Characteristics of the execution of the Action. Include disruptiveness and reversibility.
- [ActionExecutionCharacteristicApiDTO](#)

actionID

- **type:** integer
- **format:** int64

- **description:** Id of the action

ActionApiInputDTO

Description

Model to describe a Filter for Actions

Required Parameters

startTime

- **type:** string
- **description:** Start time of the period to filter, based on Actions Creation Time

Optional Parameters

actionRelationTypeFilter

- **type:** array
- **description:** Filters the main list of actions based on the types of relationships they have to other actions.
- – **type:** string
 - **enum:** ['NONE', 'BLOCKED_BY', 'BLOCKING', 'CAUSED_BY', 'CAUSING']

environmentType

- **type:** string
- **description:** Filter the actions by Environment Type
- **enum:** ['ONPREM', 'CLOUD']

costType

- **type:** string
- **description:** Filter the actions by cost Type
- **enum:** ['SAVING', 'INVESTMENT']

descriptionQuery

- **description:** This query will match the details field of the ActionApiDTO to return actions that match the specified expression.
- [QueryInputApiDTO](#)

riskQuery

- **description:** This query will match the risk description field of the ActionApiDTO to return actions that match the specified expression.
- [QueryInputApiDTO](#)

executionCharacteristics

- **description:** Characteristics of the execution of the action, including disruptiveness and reversibility.
- [ActionExecutionCharacteristicInputApiDTO](#)

savingsAmountRange

- **description:** This field will match the costPrice statistic field of the ActionApiDTO to return actions that have a costPrice amount between minValue and maxValue, inclusive
- [RangeInputApiDTO](#)

hasSchedule

- **type:** boolean
- **description:** If true, only actions that have an associated execution schedule will be returned.

hasPrerequisites

- **type:** boolean
- **description:** If true, only actions that have a prerequisite preventing execution of the action will be returned.

endTime

- **type:** string
- **description:** End time of the period to filter, based on Actions Creation Time

cleared

- **type:** boolean
- **description:** Filter by Actions Executed

cumulative

- **type:** boolean
- **description:** Show the action savings as cumulative values

hasReservedInstance

- **type:** boolean
- **description:** Filter the actions by whether having related reserved instance

excludeNotifications

- **type:** boolean
- **description:** Exclude the notifications from the result

limitEntities

- **type:** integer
- **format:** int32
- **description:** Limit number of entities in the result

detailLevel

- **type:** string
- **description:** Detail level of the Action, 'standard' is the default value
- **enum:** ['STANDARD', 'EXECUTION']

relatedEntityTypes

- **type:** array
- **example:** Selecting a VCD, and specifying "related_entities": ["VirtualMachine"] will include the actions for any VM in the given VDC
- **description:** Related Entity Types to include from the supply chain for this entity
- – **type:** string

groupBy

- **type:** array
- **description:** Fields used to Group the Stats
- – **type:** string

actionTypeList

- **type:** array
- – **type:** string
 - **enum:** ['NONE', 'START', 'MOVE', 'SCALE', 'ALLOCATE', 'SUSPEND', 'TERMINATE', 'SPAWN', 'ADD_PROVIDER', 'CHANGE', 'REMOVE_PROVIDER', 'PROVISION', 'RECONFIGURE', 'RESIZE', 'RESIZE_CAPACITY', 'WARN', 'RECONFIGURE_THRESHOLD', 'DELETE', 'RIGHT_SIZE', 'RESERVE_ON_PM', 'RESERVE_ON_DS', 'RESIZE_FOR_EFFICIENCY', 'RESIZE_FOR_PERFORMANCE', 'CROSS_TARGET_MOVE', 'MOVE_TOGETHER', 'ACTIVATE', 'DEACTIVATE', 'BUY_RI']

actionStateList

- **type:** array
- – **type:** string
 - **enum:** ['PENDING_ACCEPT', 'ACCEPTED', 'REJECTED', 'PRE_IN_PROGRESS', 'POST_IN_PROGRESS', 'IN_PROGRESS', 'SUCCEEDED', 'FAILED', 'RECOMMENDED', 'DISABLED', 'QUEUED', 'CLEARED', 'ACCOUNTING', 'READY', 'FAILING']

actionModeList

- **type:** array
- – **type:** string
 - **enum:** ['DISABLED', 'RECOMMEND', 'EXTERNAL_APPROVAL', 'MANUAL', 'AUTOMATIC', 'COLLECTION']

riskSeverityList

- **type:** array
- – **type:** string

riskSubCategoryList

- **type:** array
- – **type:** string

ActionDetailsApiDTO

Description

Parent class for action details. Implementing classes include: CloudResizeActionDetailsApiDTO, NoDetailsApiDTO, RIBuyActionDetailsApiDTO, CloudProvisionActionDetailsApiDTO, CloudSuspendActionDetailsApiDTO, OnPremResizeActionDetailsApiDTO and ReconfigureActionDetailsApiDTO.

Required Parameters

actionDetailType

- **type:** string

actionType

- **type:** string

ActionExecutionApiDTO

Description

Model to describe an Action Execution.

Required Parameters

acceptTime

- **type:** string
- **description:** Time when actions were accepted (in ISO8601 format - YYYY-MM-DDTHH:MM:SS)

actionIds

- **type:** array
- **description:** List of action IDs
- – **type:** string
- **maxItems:** 2147483647
- **minItems:** 1

id

- **type:** string
- **description:** Action Execution ID

skippedActions

- **type:** array
- **description:** List of actions that were skipped in execution
- – [SkippedActionApiDTO](#)

ActionExecutionAuditApiDTO

Description

Model to describe an Action Execution status.

Required Parameters

executionTime

- **type:** string
- **description:** Start of the execution time

state

- **type:** string
- **description:** State of the execution
- **enum:** ['PENDING_ACCEPT', 'ACCEPTED', 'REJECTED', 'PRE_IN_PROGRESS', 'POST_IN_PROGRESS', 'IN_PROGRESS', 'SUCCEEDED', 'FAILED', 'RECOMMENDED', 'DISABLED', 'QUEUED', 'CLEARED', 'ACCOUNTING', 'READY', 'FAILING']

Optional Parameters

completionTime

- **type:** string
- **description:** End of the execution time

message

- **type:** string
- **description:** Status message, if the Action failed, it will contains the Error details

progress

- **type:** integer
- **format:** int32
- **description:** Action execution progress value, from 0 to 100

ActionExecutionCharacteristicApiDTO

Description

Model to describe action execution characteristics

Optional Parameters

disruptiveness

- **type:** string
- **description:** whether action is disruptive.
- **enum:** ['DISRUPTIVE', 'NON_DISRUPTIVE']

reversibility

- **type:** string
- **description:** whether action is reversible.
- **enum:** ['REVERSIBLE', 'IRREVERSIBLE']

ActionExecutionCharacteristicInputApiDTO

Description

Model to describe action execution characteristics

Optional Parameters

disruptiveness

- **type:** string
- **description:** whether action is disruptive.
- **enum:** ['DISRUPTIVE', 'NON_DISRUPTIVE']

reversibility

- **type:** string
- **description:** whether action is reversible.
- **enum:** ['REVERSIBLE', 'IRREVERSIBLE']

ActionExecutionInputApiDto

Description

Model to describe an Action Execution input.

Required Parameters

actionIds

- **type:** array

- **description:** List of action IDs
- – **type:** string
- **maxItems:** 2147483647
- **minItems:** 1

ActionResourceImpactStatApiInputDTO

Description

Model to describe an input for Action Resource Impact Stats

Required Parameters

actionResourceImpactStatList

- **type:** array
- **description:** List of Action Resource Impact Stat Inputs
- – [ActionResourceImpactStatInput](#)

Optional Parameters

actionRelationTypeFilter

- **type:** array
- **description:** Filters the main list of actions based on the types of relationships they have to other actions.
- – **type:** string
- **enum:** ['NONE', 'BLOCKED_BY', 'BLOCKING', 'CAUSED_BY', 'CAUSING']

environmentType

- **type:** string
- **description:** Filter the actions by Environment Type
- **enum:** ['ONPREM', 'CLOUD']

costType

- **type:** string
- **description:** Filter the actions by cost Type
- **enum:** ['SAVING', 'INVESTMENT']

descriptionQuery

- **description:** This query will match the details field of the ActionApiDTO to return actions that match the specified expression.
- [QueryInputApiDTO](#)

riskQuery

- **description:** This query will match the risk description field of the ActionApiDTO to return actions that match the specified expression.
- [QueryInputApiDTO](#)

executionCharacteristics

- **description:** Characteristics of the execution of the action, including disruptiveness and reversibility.
- [ActionExecutionCharacteristicInputApiDTO](#)

savingsAmountRange

- **description:** This field will match the costPrice statistic field of the ActionApiDTO to return actions that have a costPrice amount between minValue and maxValue, inclusive
- **RangeInputApiDTO**

hasSchedule

- **type:** boolean
- **description:** If true, only actions that have an associated execution schedule will be returned.

hasPrerequisites

- **type:** boolean
- **description:** If true, only actions that have a prerequisite preventing execution of the action will be returned.

actionStateList

- **type:** array
- – **type:** string
 - **enum:** ['PENDING_ACCEPT', 'ACCEPTED', 'REJECTED', 'PRE_IN_PROGRESS', 'POST_IN_PROGRESS', 'IN_PROGRESS', 'SUCCEEDED', 'FAILED', 'RECOMMENDED', 'DISABLED', 'QUEUED', 'CLEARED', 'ACCOUNTING', 'READY', 'FAILING']

actionModeList

- **type:** array
- – **type:** string
 - **enum:** ['DISABLED', 'RECOMMEND', 'EXTERNAL_APPROVAL', 'MANUAL', 'AUTOMATIC', 'COLLECTION']

riskSeverityList

- **type:** array
- – **type:** string

riskSubCategoryList

- **type:** array
- – **type:** string

ActionResourceImpactStatInput

Description

Model to describe an Action Resource Impact Stat Input

Required Parameters

actionType

- **type:** string
- **description:** Action Type
- **enum:** ['NONE', 'START', 'MOVE', 'SCALE', 'ALLOCATE', 'SUSPEND', 'TERMINATE', 'SPAWN', 'ADD_PROVIDER', 'CHANGE', 'REMOVE_PROVIDER', 'PROVISION', 'RECONFIGURE', 'RESIZE', 'RESIZE_CAPACITY', 'WARN', 'RECONFIGURE_THRESHOLD', 'DELETE', 'RIGHT_SIZE', 'RESERVE_ON_PM', 'RESERVE_ON_DS', 'RESIZE_FOR_EFFICIENCY', 'RESIZE_FOR_PERFORMANCE', 'CROSS_TARGET_MOVE', 'MOVE_TOGETHER', 'ACTIVATE', 'DEACTIVATE', 'BUY_RI']

commodityType

- **type:** string
- **example:** VCPU
- **description:** Commodity Type that could be impacted by the action. For example, VCPU or VMEM for a Resize VM action.
- **enum:** ['ACTION_PERMIT', 'ACTIVE_SESSIONS', 'APPLICATION', 'BALLOONING', 'BUFFER_COMMODITY', 'CLUSTER', 'COLLECTION_TIME', 'COOLING', 'CONNECTION', 'COUPON', 'CPU', 'CPU_ALLOCATION', 'CPU_PROVISIONED', 'CPU_REQUEST_ALLOCATION', 'CROSS_CLOUD_MOVE_SVC', 'CROSS_CLUSTER_MOVE_SVC', 'DATACENTER', 'DATASTORE', 'DB_CACHE_HIT_RATE', 'DB_MEM', 'DISK_ARRAY_ACCESS', 'DRS_SEGMENTATION', 'DSPM_ACCESS', 'EXTENT', 'FLOW', 'FLOW_ALLOCATION', 'HEAP', 'HOST_LUN_ACCESS', 'IMAGE_CPU', 'IMAGE_MEM', 'IMAGE_STORAGE', 'INSTANCE_DISK_SIZE', 'INSTANCE_DISK_TYPE', 'IO_THROUGHPUT', 'LICENSE_ACCESS', 'MEM', 'MEM_ALLOCATION', 'MEM_REQUEST_ALLOCATION', 'MEM_PROVISIONED', 'NET_THROUGHPUT', 'NETWORK', 'NUM_DISK', 'NUMBER_CONSUMERS', 'NUM_VCORE', 'POOL_CPU', 'POOL_MEM', 'POOL_STORAGE', 'PORT_CHANNEL', 'POWER', 'Q16_VCPU', 'Q1_VCPU', 'Q2_VCPU', 'Q32_VCPU', 'Q4_VCPU', 'Q64_VCPU', 'Q8_VCPU', 'RESPONSE_TIME', 'SAME_CLUSTER_MOVE_SVC', 'SEGMENTATION', 'SLA_COMMODITY', 'SOFTWARE_LICENSE_COMMODITY', 'SPACE', 'STORAGE_ACCESS', 'STORAGE_ALLOCATION', 'STORAGE_AMOUNT', 'STORAGE_CLUSTER', 'STORAGE_LATENCY', 'STORAGE_PROVISIONED', 'SWAPPING', 'THREADS', 'TRANSACTION', 'TRANSACTION_LOG', 'VCPU', 'VCPU_LIMIT_QUOTA', 'VCPU_REQUEST', 'VCPU_REQUEST_QUOTA', 'VDC', 'VMEM', 'VMEM_LIMIT_QUOTA', 'VMEM_REQUEST', 'VMEM_REQUEST_QUOTA', 'VMPPM_ACCESS', 'VSTORAGE', 'ZONE', 'LICENSE_COMMODITY', 'Q3_VCPU', 'NUMBER_CONSUMERS_PM', 'Q6_VCPU', 'Q7_VCPU', 'QN_VCPU', 'RIGHT_SIZE_SVC', 'RIGHT_SIZE_DOWN', 'MOVE', 'Q5_VCPU', 'STORAGE', 'NUMBER_CONSUMERS_STORAGE', 'ACCESS', 'RIGHT_SIZE_UP', 'VAPP_ACCESS', 'HOT_STORAGE', 'HA_COMMODITY', 'NETWORK_POLICY', 'SERVICE_LEVEL_CLUSTER', 'PROCESSING_UNITS', 'TENANCY_ACCESS', 'TEMPLATE_ACCESS', 'BURST_BALANCE', 'DESIRED_COUPON', 'NETWORK_INTERFACE_COUNT', 'BICLIQUE', 'TAINT', 'LABEL', 'UNKNOWN']

targetEntityType

- **type:** string
- **description:** Target entity type for an action. For example, VirtualMachine for a resize virtual machine action
- **enum:** ['ApplicationComponent', 'VirtualMachine', 'Storage', 'DiskArray', 'Database', 'DatabaseServer', 'Container', 'LogicalPool']

ActionScheduleApiDTO

Description

Model to describe an Action Schedule.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

nextOccurrence

- **type:** string
- **description:** The time of the next occurrence represented in ISO8601 local time (YYYY-MM-DDTHH:MM:SS). For example, 2019-04-04T19:15.

nextOccurrenceTimestamp

- **type:** integer
- **format:** int64
- **description:** The time of the next occurrence of this schedule represented in Timestamp in milliseconds. For example, 1562100619000

timeZoneId

- **type:** string
- **description:** The timezone of the schedule

mode

- **type:** string
- **description:** The action mode affected by the schedule
- **enum:** ['DISABLED', 'RECOMMEND', 'EXTERNAL_APPROVAL', 'MANUAL', 'AUTOMATIC', 'COLLECTION']

acceptedByUserForMaintenanceWindow

- **type:** boolean
- **description:** Boolean signifying acceptance or rejection of the action.

userName

- **type:** string
- **description:** The user who accepted the action for the maintenance window.

remaingTimeActiveInMs

- **type:** integer
- **format:** int64
- **description:** The amount of time that the schedule is going to be active at the time of call in milliseconds. This field will not be populated if the schedule is not currently active.

ActionScopesApiInputDTO

Description

Model to describe the request for Actions in multiple Scopes

Required Parameters**actionInput**

- **description:** List of requested actions
- **ActionApiInputDTO**

Optional Parameters**scopes**

- **type:** array
- **description:** List of uuid to use as scope

- – **type:** string

relatedType

- **type:** string
- **description:** Get the actions for the entity type related to the scopes

ActionScopesResourceImpactStatApiInputDTO

Description

Model to describe the request for Actions Resource Impacts in multiple Scopes

Required Parameters

actionResourceImpactStatApiInput

- **description:** Requested action resource impact stats
- **ActionResourceImpactStatApiInputDTO**

scopes

- **type:** array
- **description:** List of uuid to use as scope
- – **type:** string

ActiveDirectoryApiDTO

Description

Model to describe an Active Directory. It contains domain name and server name which are global to Turbonomic server.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

domainName

- **type:** string
- **description:** The domain name of current active directory

loginProviderURI

- **type:** string
- **description:** The server name of current active directory

isSecure

- **type:** boolean

- **description:** The server name of current active directory

groups

- **type:** array
- **description:** Active directory groups defined in Ops Mgr for current active directory
- – [ActiveDirectoryGroupApiDTO](#)

ActiveDirectoryGroupApiDTO

Description

Model to describe an Active Directory Group. Active Directory groups are used to manage user authentication. You can specify role and scope for the group, and any member of the AD group can log into Turbonomic with those privileges.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

type

- **type:** string
- **description:** The user type for current active directory group

roleName

- **type:** string
- **description:** The user role name of current active directory group

scope

- **type:** array
- **description:** The scope of current active directory group
- – [GroupApiDTO](#)

AddObjectApiDTO

Description

Model to describe an add change in the scenario

Optional Parameters

projectionDays

- **type:** array
- **description:** List of projection days, indicate when to apply the changes
- – **type:** integer

- **format:** int32

target

- **description:** Target of the change, entity or group
- **BaseApiDTO**

count

- **type:** integer
- **format:** int32
- **description:** How many times to apply the add change

targetEntityType

- **type:** string
- **description:** Type of entity to add from group target

AggregateCommodityFieldApiDTO

Description

Inherits From

This DTO inherits from [FieldApiDTO](#)

Required Parameters

aggregation

- **type:** string
- **description:** The type of aggregation.
- **readOnly:** True
- **enum:** ['TOTAL', 'AVERAGE']

commodityAttribute

- **type:** string
- **description:** The commodity attribute.
- **readOnly:** True
- **enum:** ['USED', 'CAPACITY', 'PEAK', 'CURRENT_UTILIZATION', 'WEIGHTED_HISTORICAL_UTILIZATION', 'PERCENTILE_HISTORICAL_UTILIZATION']

commodityType

- **type:** string
- **description:** The commodity name.
- **readOnly:** True
- **enum:** ['ACTION_PERMIT', 'ACTIVE_SESSIONS', 'APPLICATION', 'BALLOONING', 'BUFFER_COMMODITY', 'CLUSTER', 'COLLECTION_TIME', 'COOLING', 'CONNECTION', 'COUPON', 'CPU', 'CPU_ALLOCATION', 'CPU_PROVISIONED', 'CPU_REQUEST_ALLOCATION', 'CROSS_CLOUD_MOVE_SVC', 'CROSS_CLUSTER_MOVE_SVC', 'DATACENTER', 'DATASTORE', 'DB_CACHE_HIT_RATE', 'DB_MEM', 'DISK_ARRAY_ACCESS', 'DRS_SEGMENTATION', 'DSPM_ACCESS', 'EXTENT', 'FLOW', 'FLOW_ALLOCATION', 'HEAP', 'HOST_LUN_ACCESS', 'IMAGE_CPU', 'IMAGE_MEM', 'IMAGE_STORAGE', 'INSTANCE_DISK_SIZE', 'INSTANCE_DISK_TYPE', 'IO_THROUGHPUT', 'LICENSE_ACCESS', 'MEM', 'MEM_ALLOCATION', 'MEM_REQUEST_ALLOCATION', 'MEM_PROVISIONED', 'NET_THROUGHPUT', 'NETWORK', 'NUM_DISK', 'NUMBER_CONSUMERS', 'NUM_VCORE', 'POOL_CPU', 'POOL_MEM', 'POOL_STORAGE',

'PORT_CHANNEL', 'POWER', 'Q16_VCPU', 'Q1_VCPU', 'Q2_VCPU', 'Q32_VCPU', 'Q4_VCPU', 'Q64_VCPU', 'Q8_VCPU', 'RESPONSE_TIME', 'SAME_CLUSTER_MOVE_SVC', 'SEGMENTATION', 'SLA_COMMODITY', 'SOFTWARE_LICENSE_COMMODITY', 'SPACE', 'STORAGE_ACCESS', 'STORAGE_ALLOCATION', 'STORAGE_AMOUNT', 'STORAGE_CLUSTER', 'STORAGE_LATENCY', 'STORAGE_PROVISIONED', 'SWAPPING', 'THREADS', 'TRANSACTION', 'TRANSACTION_LOG', 'VCPU', 'VCPU_LIMIT_QUOTA', 'VCPU_REQUEST', 'VCPU_REQUEST_QUOTA', 'VDC', 'VMEM', 'VMEM_LIMIT_QUOTA', 'VMEM_REQUEST', 'VMEM_REQUEST_QUOTA', 'VMPPM_ACCESS', 'VSTORAGE', 'ZONE', 'LICENSE_COMMODITY', 'Q3_VCPU', 'NUMBER_CONSUMERS_PM', 'Q6_VCPU', 'Q7_VCPU', 'QN_VCPU', 'RIGHT_SIZE_SVC', 'RIGHT_SIZE_DOWN', 'MOVE', 'Q5_VCPU', 'STORAGE', 'NUMBER_CONSUMERS_STORAGE', 'ACCESS', 'RIGHT_SIZE_UP', 'VAPP_ACCESS', 'HOT_STORAGE', 'HA_COMMODITY', 'NETWORK_POLICY', 'SERVICE_LEVEL_CLUSTER', 'PROCESSING_UNITS', 'TENANCY_ACCESS', 'TEMPLATE_ACCESS', 'BURST_BALANCE', 'DESIRED_COUPON', 'NETWORK_INTERFACE_COUNT', 'BICLIQUE', 'TAINT', 'LABEL', 'UNKNOWN']

AggregatedHealthResponseDTO

Description

A DTO for a single aggregated health response item.

Required Parameters

healthState

- **type:** string
- **description:** The (aggregated) health state for the subcategory.
- **enum:** ['CRITICAL', 'MAJOR', 'MINOR', 'NORMAL']

numberOfItems

- **type:** integer
- **format:** int32
- **description:** Number of entities whose state matches healthState.

subcategory

- **type:** string
- **description:** Health subcategory.

Optional Parameters

recommendations

- **type:** array
- **description:** A list of recommendations specific for each problem (error) type.
- – **Recommendation**

AutomatedEntityDefinitionData

Description

Inherits From

This DTO inherits from [IEntityDefinitionData](#)

Required Parameters

entityType

- **type:** string
- **description:** Connected entity type
- **enum:** ['ApplicationComponent', 'BusinessTransaction', 'Container', 'ContainerPod', 'DatabaseServer', 'Service', 'VirtualMachine']

namePrefix

- **type:** string
- **description:** Naming prefix for automated entity definition

Optional Parameters

generationAndConnectionAttribute

- **description:** Defined criteria of connected entities
- **[FilterApiDTO](#)**

BaseApiDTO

Description

Basic information of an entity

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

BaseCommodityApiDTO

Description

Describes a commodity

Required Parameters

type

- **type:** string
- **description:** The type of the commodity
- **enum:** ['ACTION_PERMIT', 'ACTIVE_SESSIONS', 'APPLICATION', 'BALLOONING', 'BUFFER_COMMODITY', 'CLUSTER', 'COLLECTION_TIME', 'COOLING', 'CONNECTION', 'COUPON', 'CPU', 'CPU_ALLOCATION', 'CPU_PROVISIONED', 'CPU_REQUEST_ALLOCATION', 'CROSS_CLOUD_MOVE_SVC', 'CROSS_CLUSTER_MOVE_SVC', 'DATACENTER', 'DATASTORE', 'DB_CACHE_HIT_RATE', 'DB_MEM', 'DISK_ARRAY_ACCESS', 'DRS_SEGMENTATION',

'DSPM_ACCESS', 'EXTENT', 'FLOW', 'FLOW_ALLOCATION', 'HEAP', 'HOST_LUN_ACCESS', 'IMAGE_CPU', 'IMAGE_MEM', 'IMAGE_STORAGE', 'INSTANCE_DISK_SIZE', 'INSTANCE_DISK_TYPE', 'IO_THROUGHPUT', 'LICENSE_ACCESS', 'MEM', 'MEM_ALLOCATION', 'MEM_REQUEST_ALLOCATION', 'MEM_PROVISIONED', 'NET_THROUGHPUT', 'NETWORK', 'NUM_DISK', 'NUMBER_CONSUMERS', 'NUM_VCPU', 'POOL_CPU', 'POOL_MEM', 'POOL_STORAGE', 'PORT_CHANNEL', 'POWER', 'Q16_VCPU', 'Q1_VCPU', 'Q2_VCPU', 'Q32_VCPU', 'Q4_VCPU', 'Q64_VCPU', 'Q8_VCPU', 'RESPONSE_TIME', 'SAME_CLUSTER_MOVE_SVC', 'SEGMENTATION', 'SLA_COMMODITY', 'SOFTWARE_LICENSE_COMMODITY', 'SPACE', 'STORAGE_ACCESS', 'STORAGE_ALLOCATION', 'STORAGE_AMOUNT', 'STORAGE_CLUSTER', 'STORAGE_LATENCY', 'STORAGE_PROVISIONED', 'SWAPPING', 'THREADS', 'TRANSACTION', 'TRANSACTION_LOG', 'VCPU', 'VCPU_LIMIT_QUOTA', 'VCPU_REQUEST', 'VCPU_REQUEST_QUOTA', 'VDC', 'VMEM', 'VMEM_LIMIT_QUOTA', 'VMEM_REQUEST', 'VMEM_REQUEST_QUOTA', 'VMPM_ACCESS', 'VSTORAGE', 'ZONE', 'LICENSE_COMMODITY', 'Q3_VCPU', 'NUMBER_CONSUMERS_PM', 'Q6_VCPU', 'Q7_VCPU', 'QN_VCPU', 'RIGHT_SIZE_SVC', 'RIGHT_SIZE_DOWN', 'MOVE', 'Q5_VCPU', 'STORAGE', 'NUMBER_CONSUMERS_STORAGE', 'ACCESS', 'RIGHT_SIZE_UP', 'VAPP_ACCESS', 'HOT_STORAGE', 'HA_COMMODITY', 'NETWORK_POLICY', 'SERVICE_LEVEL_CLUSTER', 'PROCESSING_UNITS', 'TENANCY_ACCESS', 'TEMPLATE_ACCESS', 'BURST_BALANCE', 'DESIRED_COUPON', 'NETWORK_INTERFACE_COUNT', 'BICLIQUE', 'TAINT', 'LABEL', 'UNKNOWN']

Optional Parameters

key

- **type:** string
- **description:** The specific commodity

units

- **type:** string
- **description:** The units in which the commodity is measured, if any

BaseGroupApiDTO

Description

Base model to describe a Group.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

membersCount

- **type:** integer
- **format:** int32
- **description:** Number of members of the Group

BasicActionApiDTO

Description

Model to tersely describe an action, providing only a set of basic fields

Optional Parameters

actionType

- **type:** string
- **description:** Type
- **enum:** ['START', 'MOVE', 'SCALE', 'ALLOCATE', 'SUSPEND', 'PROVISION', 'RECONFIGURE', 'RESIZE', 'DELETE', 'RIGHT_SIZE', 'BUY_RI']

details

- **type:** string
- **description:** A user-readable string describing the action

target

- **description:** Target entity for an action. For example, the VM in a Resize Action, or the host for a VM move
- [DiscoveredEntityApiDTO](#)

currentEntity

- **description:** Current entity, such as the current host that a VM resides on for a VM move action
- [DiscoveredEntityApiDTO](#)

newEntity

- **description:** Destination entity, such as the host that a VM will move to for a VM move action
- [DiscoveredEntityApiDTO](#)

actionID

- **type:** integer
- **format:** int64
- **description:** Id of the action

BillingFamilyApiDTO

Description

Inherits From

This DTO inherits from [GroupApiDTO](#)

Optional Parameters

masterAccountUuid

- **type:** string
- **description:** The UUID of the master account.

businessUnitApiDTOList

- **type:** array

- **description:** List of business units, for all accounts in this billing family.
- – [BusinessUnitApiDTO](#)

BooleanConditionApiDTO

Description

Inherits From

This DTO inherits from [ConditionApiDTO](#)

Required Parameters

value

- **type:** boolean
- **description:** The value of the field must be equal to this boolean value
- **readOnly:** True

BooleanFieldValueApiDTO

Description

Inherits From

This DTO inherits from [FieldValueApiDTO](#)

Required Parameters

value

- **type:** boolean
- **description:** The value.
- **readOnly:** True

BusinessUnitApiDTO

Description

Model to describe the property of a business unit.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

discount

- **type:** number
- **format:** float
- **description:** Entity discount percentage

priceAdjustment

- **description:** Entity price adjustment percentage
- **PriceAdjustmentDTO**

accountId

- **type:** string
- **description:** Account ID

master

- **type:** boolean
- **description:** Flag which shows whether this account is master or not

associatedTargetId

- **type:** integer
- **format:** int64
- **description:** Target associated with this account, if workloads related to this account are being discovered. If no workloads are discovered for this account, the associatedTargetId will be empty.

budget

- **description:** Budget of the business unit, user only need to set value and units(monthly)
- **StatApiDTO**

businessUnitType

- **type:** string
- **description:** Type of the business unit instance
- **enum:** ['BUDGET', 'DISCOUNT', 'PRICE_ADJUSTMENT', 'DISCOVERED']

cloudType

- **type:** string
- **description:** Type of the cloud target which is related to current business account.
- **enum:** ['AWS', 'AZURE', 'GCP', 'UNKNOWN']

accountType

- **type:** string
- **description:** The category of the current cloud account.
- **enum:** ['STANDARD', 'GOVERNMENT_US']

riSupported

- **type:** boolean
- **description:** Flag which shows whether this account is RI supported

childrenBusinessUnits

- **type:** array
- **description:** UUIDs of the discovered children business units that will share the budget or discounts configuration of this business unit.
- – **type:** string

targets

- **type:** array
- **description:** Targets associated with the business unit
- – **TargetApiDTO**

costPrice

- **type:** number
- **format:** float
- **description:** Cost price per Hour

severity

- **type:** string
- **description:** Calculated using the highest severity of the member entities
- **enum:** ['UNKNOWN', 'NORMAL', 'MINOR', 'MAJOR', 'CRITICAL']

membersCount

- **type:** integer
- **format:** int32
- **description:** Number of members of the business unit

memberType

- **type:** string
- **description:** The type of service entities comprising the business unit

related

- **description:** The rate card and the custom pricing information the business unit is using
- **BusinessUnitRelatedApiDTO**

resourceGroupsCount

- **type:** integer
- **format:** int32
- **description:** The number of Resource Groups belonging to the business unit

displayable

- **type:** boolean
- **description:** Whether business unit is displayable or not

pricingIdentifiers

- **type:** object
- **description:** Pricing identifiers for the business unit
- **additionalProperties:** {'type': 'string'}

BusinessUnitApiInputDTO

Description

Model to describe the parameters for creating a business unit.

Required Parameters

name

- **type:** string
- **description:** Name of the business unit

Optional Parameters

budget

- **description:** Budget of the business unit, user only need to set value
- [StatApiDTO](#)

childrenBusinessUnits

- **type:** array
- **description:** UUIDs of the discovered children business units, that will share the budget or discounts configuration of this business unit.
- – **type:** string

discount

- **type:** number
- **format:** float
- **description:** Business unit enterprise-level discount percentage. It will come to effect if cloud service or template-level discounts are not configured.

priceAdjustment

- **description:** Business unit enterprise-level price adjustment percentage. It will come to effect if cloud service or template-level discounts are not configured.
- [PriceAdjustmentDTO](#)

targets

- **type:** array
- – **type:** string

nameWithBusinessAccountType

- **type:** string

BusinessUnitPriceAdjustmentApiDTO

Description

Price adjustment values for cloud services and templates related to a business unit. The price adjustment configured on an user-defined business unit apply to cloud services and templates offered by the children business units.

Optional Parameters

servicePriceAdjustments

- **type:** array
- **description:** Price adjustment information for the related cloud services and templates.
- – [CloudServicePriceAdjustmentApiDTO](#)

serviceDiscounts

- **type:** array
- **description:** Discount information for the related cloud services and templates
- – [CloudServicePriceAdjustmentApiDTO](#)

BusinessUnitRelatedApiDTO

Description

Model to describe relationship between a business unit and its related rate cards and price adjustments

Optional Parameters

rateCard

- **description:** Rate Card related to this Business Unit.
- [BaseApiDTO](#)

priceAdjustment

- **description:** Price Adjustment related to this Business Unit.
- [BaseApiDTO](#)

BusinessUserEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

sessions

- **type:** array
- **description:** Information about sessions to entities (VM or other) established by this BusinessUser.
- – [BusinessUserSessionApiDTO](#)

BusinessUserSessionApiDTO

Description

Session information for a connection established by BusinessUser to an entity (VM or other)

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

businessUserUuid

- **type:** string
- **description:** UUID of the connected BusinessUser

connectedEntityUuid

- **type:** string
- **description:** UUID of the entity that user has a connection to

duration

- **type:** integer
- **format:** int64
- **description:** Time elapsed since the session start in seconds- sessions are always timed

ChangePasswordApiDTO

Description

Optional Parameters

oldPassword

- **type:** string

newPassword

- **type:** string

ClientInputDTO

Description

Required Parameters

name

- **type:** string
- **description:** Name of client

supportedServices

- **type:** array
- **description:** List of supported services

- – **type:** string

ClientNetworkTokenApiDTO

Description

Optional Parameters

id

- **type:** string
- **description:** id

tokenData

- **type:** string
- **description:** Token data

ClientServiceApiDTO

Description

Optional Parameters

id

- **type:** string
- **description:** id

supportedServices

- **type:** array
- **description:** Supported services
- – **type:** string

secret

- **type:** string
- **description:** Secret

name

- **type:** string
- **description:** Name of client

CloudAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

zone

- **description:** The zone of the cloud entity
- **BaseApiDTO**

region

- **description:** The region of the cloud entity
- **BaseApiDTO**

businessAccount

- **description:** The BusinessAccount of the cloud entity
- **BaseApiDTO**

resourceGroup

- **description:** The ResourceGroup of the cloud entity
- **BaseApiDTO**

template

- **description:** The template used to generate the entity
- **BaseApiDTO**

billingType

- **type:** string
- **description:** The Cloud Billing type

tier

- **type:** string
- **description:** The Tier of the storage

riCoveragePercentage

- **type:** number
- **format:** float
- **description:** The RI coverage percentage

riCoverage

- **description:** Used value stores VM coupons in use, capacity stores coupon capacity
- **StatApiDTO**

onDemandCost

- **type:** number
- **format:** float
- **description:** On-demand cost paid for workload per Hour (includes Compute and License on-demand costs)

enhancedNetworking

- **type:** string
- **description:** The type of Enhanced Networking supported. If the entity is an AWS VM, this field will be populated by a value describing what kind of enhanced networking, if any, the VM is currently using. If the entity is not an AWS VM, this field is not relevant and will not be populated or displayed.
- **enum:** ['NONE', 'ENA']

enaActive

- **type:** string
- **description:** Whether ENA is active. If the entity is an AWS VM, this field will be populated by a value describing whether ENA is currently in use or not. If the entity is not an AWS VM, this field is not relevant and will not be populated or displayed.
- **enum:** ['Active', 'Inactive']

virtualizationType

- **type:** string
- **description:** The virtualization type. If the entity is an AWS VM, this field will be populated by a value describing what kind of virtualization type, if any, the VM is currently using. If the entity is not an AWS VM, this field is not relevant and will not be populated or displayed.
- **enum:** ['PVM', 'HVM']

architecture

- **type:** string
- **description:** If the entity is an AWS VM, this field will be populated by a value describing what is the architecture of the VM. If the entity is not an AWS VM, this field is not relevant and will not be populated or displayed.
- **enum:** ['32-bit', '64-bit']

nvme

- **type:** string
- **description:** NVMe driver support. If the entity is an AWS VM, this field will be true if NVMe driver installed. If the entity is not an AWS VM, this field is not relevant and will not be populated or displayed.
- **enum:** ['Installed', 'Not installed']

entityUptime

- **description:** The entity uptime
- **EntityUptimeApiDTO**

tenancy

- **type:** string
- **description:** The tenancy type for VMs
- **enum:** ['DEFAULT', 'DEDICATED', 'HOST']

CloudCommitmentAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

startTimeInMilliseconds

- **type:** integer
- **format:** int64
- **description:** The start time of the Cloud Commitment in UTC.

expirationTimeInMilliseconds

- **type:** integer
- **format:** int64
- **description:** The expiration time of the Cloud Commitment in UTC.

termInMilliseconds

- **type:** integer
- **format:** int64
- **description:** The term of the Cloud Commitment.

cloudCommitmentScopeType

- **type:** string
- **description:** The scope of the Cloud Commitment.
- **enum:** ['FamilyScoped', 'FamilyAndOSScoped', 'CloudServiceScoped']

cloudCommitmentScopeDTO

- **description:** The info about the scope of the cloud commitment.
- [CloudCommitmentScopeDTO](#)

cloudCommitmentCapacityApiDTO

- **description:** The capacity specific info of the cloud commitment.
- [CloudCommitmentCapacityApiDTO](#)

payment

- **type:** string
- **description:** Payment option of the cloud commitment.
- **enum:** ['ALL_UPFRONT', 'PARTIAL_UPFRONT', 'NO_UPFRONT']

providerSpecificType

- **type:** string
- **description:** The provider specific type.
- **enum:** ['SAVINGS_PLAN', 'COMMITTED_USE']

commitmentStatus

- **type:** string
- **description:** The cloud commitment status.
- **enum:** ['Unknown', 'Pending', 'Active', 'Expired', 'Canceled']

CloudCommitmentCapacityApiDTO

Description

Model to describe cloud commitment capacity

Optional Parameters**instanceCapacity**

- **type:** integer
- **format:** int64
- **description:** The instance capacity of the cloud commitment.

spendCapacity

- **type:** number
- **format:** double
- **description:** The spend capacity of the cloud commitment.

commoditiesBought

- **type:** object
- **description:** The capacity for each type commodity bought by the commitment.
- **additionalProperties:** {'type': 'number', 'format': 'double'}

CloudCommitmentScopeDTO

Description

Model to describe cloud commitment scope.

Optional Parameters

cloudFamilyReferenceApiDTO

- **description:** The family scoped type specific info of the cloud commitment. If null, indicates service scoped cloud commitment
- [CloudFamilyReferenceApiDTO](#)

CloudFamilyReferenceApiDTO

Description

Model describe a reference to a cloud family

Optional Parameters

family

- **type:** string
- **description:** The family of the Cloud Commitment.

entityType

- **type:** string
- **description:** The entity type the Cloud Commitment applies to.
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

CloudProvisionActionDetailsApiDTO

Description

Inherits From

This DTO inherits from [ActionDetailsApiDTO](#)

Optional Parameters

onDemandRate

- **type:** number
- **format:** float

onDemandCost

- **type:** number
- **format:** float

subType

- **type:** string

CloudResizeActionDetailsApiDTO

Description

Inherits From

This DTO inherits from [ActionDetailsApiDTO](#)

Optional Parameters

onDemandRateBefore

- **type:** number
- **format:** float

onDemandRateAfter

- **type:** number
- **format:** float

onDemandCostBefore

- **type:** number
- **format:** float

onDemandCostAfter

- **type:** number
- **format:** float

riCoverageBefore

- **description:** RI coupons used and capacity of the target entity before action
- **[StatApiDTO](#)**

riCoverageAfter

- **description:** RI coupons used and capacity of the target entity after action
- **[StatApiDTO](#)**

entityUptime

- **description:** The entity uptime which was taken into account when generating the action

- **EntityUptimeApiDTO**

subType

- **type:** string

CloudServicePriceAdjustmentApiDTO

Description

Price adjustments for cloud service and related templates specified for a certain pricing model.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

discount

- **type:** number
- **format:** float
- **description:** Entity discount percentage

priceAdjustment

- **description:** Entity price adjustment percentage
- **PriceAdjustmentDTO**

pricingModel

- **type:** string
- **description:** Pricing model, 'On demand' for time-based, 'Reserved' for coupon-based, 'Spot' for customer bidding
- **enum:** ['ON_DEMAND', 'RESERVED', 'SPOT']

templateDiscounts

- **type:** array
- **description:** Discount values for the templates offered by the cloud service under certain pricing model.
- – **TemplatePriceAdjustmentDTO**

templatePriceAdjustments

- **type:** array

- **description:** Price adjustment values for the templates offered by the cloud service under certain pricing model.
- – [TemplatePriceAdjustmentDTO](#)

CloudServicePricingModelApiDTO

Description

Cloud service + pricing model pair that is available for a business unit.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

discount

- **type:** number
- **format:** float
- **description:** Entity discount percentage

priceAdjustment

- **description:** Entity price adjustment percentage
- [PriceAdjustmentDTO](#)

pricingModel

- **type:** string
- **description:** Pricing model, 'On demand' for time-based, 'Reserved' for coupon-based, 'Spot' for customer bidding
- **enum:** ['ON_DEMAND', 'RESERVED', 'SPOT']

CloudSuspendActionDetailsApiDTO

Description

Inherits From

This DTO inherits from [ActionDetailsApiDTO](#)

Optional Parameters

onDemandRate

- **type:** number
- **format:** float

onDemandCost

- **type:** number
- **format:** float

subType

- **type:** string

CommodityFieldApiDTO

Description

Inherits From

This DTO inherits from [FieldApiDTO](#)

Required Parameters

commodityAttribute

- **type:** string
- **description:** The commodity attribute.
- **readOnly:** True
- **enum:** ['USED', 'CAPACITY', 'PEAK', 'CURRENT_UTILIZATION', 'WEIGHTED_HISTORICAL_UTILIZATION', 'PERCENTILE_HISTORICAL_UTILIZATION']

commodityType

- **type:** string
- **description:** The commodity name.
- **readOnly:** True
- **enum:** ['ACTION_PERMIT', 'ACTIVE_SESSIONS', 'APPLICATION', 'BALLOONING', 'BUFFER_COMMODITY', 'CLUSTER', 'COLLECTION_TIME', 'COOLING', 'CONNECTION', 'COUPON', 'CPU', 'CPU_ALLOCATION', 'CPU_PROVISIONED', 'CPU_REQUEST_ALLOCATION', 'CROSS_CLOUD_MOVE_SVC', 'CROSS_CLUSTER_MOVE_SVC', 'DATACENTER', 'DATASTORE', 'DB_CACHE_HIT_RATE', 'DB_MEM', 'DISK_ARRAY_ACCESS', 'DRS_SEGMENTATION', 'DSPM_ACCESS', 'EXTENT', 'FLOW', 'FLOW_ALLOCATION', 'HEAP', 'HOST_LUN_ACCESS', 'IMAGE_CPU', 'IMAGE_MEM', 'IMAGE_STORAGE', 'INSTANCE_DISK_SIZE', 'INSTANCE_DISK_TYPE', 'IO_THROUGHPUT', 'LICENSE_ACCESS', 'MEM', 'MEM_ALLOCATION', 'MEM_REQUEST_ALLOCATION', 'MEM_PROVISIONED', 'NET_THROUGHPUT', 'NETWORK', 'NUM_DISK', 'NUMBER_CONSUMERS', 'NUM_VCORE', 'POOL_CPU', 'POOL_MEM', 'POOL_STORAGE', 'PORT_CHANNEL', 'POWER', 'Q16_VCPU', 'Q1_VCPU', 'Q2_VCPU', 'Q32_VCPU', 'Q4_VCPU', 'Q64_VCPU', 'Q8_VCPU', 'RESPONSE_TIME', 'SAME_CLUSTER_MOVE_SVC', 'SEGMENTATION', 'SLA_COMMODITY', 'SOFTWARE_LICENSE_COMMODITY', 'SPACE', 'STORAGE_ACCESS', 'STORAGE_ALLOCATION', 'STORAGE_AMOUNT', 'STORAGE_CLUSTER', 'STORAGE_LATENCY', 'STORAGE_PROVISIONED', 'SWAPPING', 'THREADS', 'TRANSACTION', 'TRANSACTION_LOG', 'VCPU', 'VCPU_LIMIT_QUOTA', 'VCPU_REQUEST', 'VCPU_REQUEST_QUOTA', 'VDC', 'VMEM', 'VMEM_LIMIT_QUOTA', 'VMEM_REQUEST', 'VMEM_REQUEST_QUOTA', 'VMPPM_ACCESS', 'VSTORAGE', 'ZONE', 'LICENSE_COMMODITY', 'Q3_VCPU', 'NUMBER_CONSUMERS_PM', 'Q6_VCPU', 'Q7_VCPU', 'QN_VCPU', 'RIGHT_SIZE_SVC', 'RIGHT_SIZE_DOWN', 'MOVE', 'Q5_VCPU',

'STORAGE', 'NUMBER_CONSUMERS_STORAGE', 'ACCESS', 'RIGHT_SIZE_UP', 'VAPP_ACCESS', 'HOT_STORAGE', 'HA_COMMODITY', 'NETWORK_POLICY', 'SERVICE_LEVEL_CLUSTER', 'PROCESSING_UNITS', 'TENANCY_ACCESS', 'TEMPLATE_ACCESS', 'BURST_BALANCE', 'DESIRED_COUPON', 'NETWORK_INTERFACE_COUNT', 'BICLIQUE', 'TAINT', 'LABEL', 'UNKNOWN']

ComputeTierAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Required Parameters

instanceStorageSize

- **type:** number
- **format:** float
- **description:** Size per instance storage in GB. This will be 0 if no instance storage's are present for compute tier.

numInstanceStorages

- **type:** number
- **format:** float
- **description:** Number of instance storage disks. Compute tiers can have 0 or more instance storage disks.

tierFamily

- **type:** string
- **description:** Family of compute tier (for example 'M4' for M4.large)

ConditionApiDTO

Description

A condition on a field of an entity or group.

Required Parameters

conditionType

- **type:** string
- **description:** Type of compared values.
- **readOnly:** True
- **enum:** ['NUMBER', 'TEXT', 'INCLUSION', 'INTEGER', 'BOOLEAN']

field

- **description:** Field to compare.
- **readOnly:** True
- **[FieldApiDTO](#)**

operator

- **type:** string

- **description:** Operator to use.
- **readOnly:** True
- **enum:** ['EQ', 'NEQ', 'GT', 'LT', 'GE', 'LE', 'LIKE', 'IN']

ConfigChangesApiDTO

Description

Policies and Settings changes in the scenario

Optional Parameters

addPolicyList

- **type:** array
- **description:** List of Placement Policies to add
- – [PolicyApiDTO](#)

removePolicyList

- **type:** array
- **description:** List of Placement Policies to remove
- – [PolicyApiDTO](#)

automationSettingList

- **type:** array
- **description:** List of automation settings
- – [SettingApiDTOString](#)

removeConstraintList

- **type:** array
- **description:** List of constraints to remove
- – [RemoveConstraintApiDTO](#)

riSettingList

- **type:** array
- **description:** List of Reserved Instance settings
- – [SettingApiDTO](#)

osMigrationSettingList

- **type:** array
- **description:** List of OS migration settings
- – [SettingApiDTOString](#)

includedCoupons

- **description:** List of Included Coupons (RIs) and related information
- [IncludedCouponsApiDTO](#)

subscription

- **description:** Subscription
- [BusinessUnitApiDTO](#)

ConstraintApiDTO

Description

Model to describe the property of constraints, corresponding to entities constraints view in ui.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

relation

- **type:** string
- **enum:** ['sold', 'bought']

entityType

- **type:** string
- **description:** entity type of providers or consumers

relatedEntities

- **type:** array
- **description:** if relation is sold they are consumers, if bought they are providers
- – [ServiceEntityApiDTO](#)

numPotentialEntities

- **type:** integer
- **format:** int32
- **description:** how many other providers/consumers can fulfill the constraint

placementOptions

- **type:** array
- **description:** A list of constraints prevent finding better placement for an entity
- – [PlacementOptionApiDTO](#)

ConstraintApiInputDTO

Description

Model to describe the property of constraints

Optional Parameters

relation

- **type:** string
- **enum:** ['sold', 'bought']

placementOptions

- **type:** array
- **description:** A list of constraints prevent finding better placement for an entity
- – [PlacementOptionApiInputDTO](#)

entityTypeFilter

- **type:** string
- **description:** potential entity type filter
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

ContainerPlatformContextAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

namespace

- **type:** string
- **description:** The namespace that a container platform entity belong to - [DEPRECATED - Use: namespaceEntity]

containerPlatformCluster

- **type:** string
- **description:** The container platform cluster name that an entity belongs to - [DEPRECATED - Use: containerClusterEntity]

workloadControllerEntity

- **description:** The workload controller entity that an entity belongs to
- [BaseApiDTO](#)

namespaceEntity

- **description:** The namespace entity that an entity belongs to
- [BaseApiDTO](#)

containerClusterEntity

- **description:** The container platform cluster entity that an entity belongs to
- [BaseApiDTO](#)

CostInputApiDTO

Description

Model to describe the request for Cost Statistics by a Time range

Optional Parameters

tagFilters

- **type:** array
- **description:** List of Tag Filters. NOTE: Required non-empty when used with costGroupBys
- – [TagApiDTO](#)

costGroupBys

- **type:** array
- **description:** List of values to group the results by. NOTE: When used non-empty tagFilters required
- – **type:** string
 - **enum:** ['TAG']

startDate

- **type:** string
- **description:** Start time of the period to filter. If startDate and endDate not provided current stats will be processed

endDate

- **type:** string
- **description:** End time of the period to filter. If startDate and endDate not provided current stats will be processed

CpuModelApiDTO

Description

Model to describe a Template: contains the resources used to Deploy a VM or to Add Workload/Supply in a Plan

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

numCores

- **type:** integer
- **format:** int32
- **description:** Number of Cores

speed

- **type:** integer
- **format:** int32
- **description:** Speed

scalingFactor

- **type:** number
- **format:** double
- **description:** Scaling Factor

modelName

- **type:** string

CriteriaOptionApiDTO

Description

Generic model used to describe a search criteria option

Optional Parameters

value

- **type:** string
- **description:** value

displayName

- **type:** string
- **description:** value to display, more readable

subValues

- **type:** array
- **description:** possible sub-values associated with the main value
- – **type:** string

DBEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

dbEngine

- **type:** string
- **description:** The Database engine

dbEdition

- **type:** string
- **description:** The Database edition

dbVersion

- **type:** string
- **description:** The Database engine version

licenseModel

- **type:** string
- **description:** The license model of the database engine

deploymentType

- **type:** string
- **description:** The deployment type of the database engine

maxConcurrentWorkers

- **type:** integer
- **format:** int32
- **description:** Maximum concurrent workers allowed for the DB

maxConcurrentSessions

- **type:** integer
- **format:** int32
- **description:** Maximum concurrent sessions allowed for the DB

pricingModel

- **type:** string
- **example:** DTU
- **description:** Database Pricing Model.
- **enum:** ['DTU', 'vCore']

replicationRole

- **type:** string
- **example:** Primary
- **description:** Replication role if DB is part of geo replicated DB. Currently applies to Azure DB only.
- **enum:** ['Primary', 'Secondary', 'None']

storageTier

- **type:** string
- **example:** GP2
- **description:** Storage Tier

dbServerName

- **type:** string
- **description:** The server name of a database

serviceTier

- **type:** string
- **example:** Hyperscale
- **description:** The service tier of a database, generally defines the storage architecture, space and I/O limits, and business continuity options related to availability and disaster recovery.
- **enum:** ['Free', 'Basic', 'Standard', 'Premium', 'GeneralPurpose', 'BusinessCritical', 'Hyperscale']

computeTier

- **type:** string
- **example:** Provisioned Compute
- **description:** The compute tier of a database. Compute tier options include the provisioned and serverless compute tiers

hardwareGeneration

- **type:** string
- **example:** Gen4
- **description:** Database hardware generation. The generation of hardware that underlies the DB instance

DatabaseServerEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

dbEngine

- **type:** string
- **description:** The Database engine

dbEdition

- **type:** string
- **description:** The Database edition

dbVersion

- **type:** string
- **description:** The Database engine version

licenseModel

- **type:** string
- **description:** The license model of the database engine

deploymentType

- **type:** string
- **description:** The deployment type of the database engine

maxConcurrentWorkers

- **type:** integer
- **format:** int32
- **description:** Maximum concurrent workers allowed for the DB

maxConcurrentSessions

- **type:** integer
- **format:** int32
- **description:** Maximum concurrent sessions allowed for the DB

pricingModel

- **type:** string
- **example:** DTU
- **description:** Pricing Model followed by DB.

storageTier

- **type:** string
- **example:** GP2
- **description:** Storage Tier

clusterRole

- **type:** string
- **description:** Cluster Role
- **enum:** ['Writer', 'Reader']

hourlyBilledOps

- **type:** number
- **format:** double
- **description:** Hourly Billed Ops - Count of operations per hour

featureStateMap

- **type:** object
- **description:** Features
- **additionalProperties:** {'type': 'string', 'enum': ['Enabled', 'Disabled', 'Unknown']}

DatabaseServerTierAspectApiDTO

Description**Inherits From**

This DTO inherits from [EntityAspect](#)

Required Parameters**tierFamily**

- **type:** string
- **description:** Family of database server tier (for example 'M5' for db.M5.large)

DatabaseTierAspectApiDTO

Description**Inherits From**

This DTO inherits from [EntityAspect](#)

Required Parameters

tierFamily

- **type:** string
- **description:** Family of database tier (for example 'S' for S4)

DemandEntityInfoDTO

Description

Model to describe a reservation entity

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

template

- **BaseApiDTO**

deploymentProfile

- **BaseApiDTO**

operationalCost

- **type:** string

placements

- **PlacementInfoDTO**

DemandReservationApiDTO

Description

Basic information of an entity

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

prefix

- **type:** string

count

- **type:** integer
- **format:** int32

status

- **type:** string

reserveDateTime

- **type:** string

expireDateTime

- **type:** string

deployDateTime

- **type:** string

reserveCount

- **type:** integer
- **format:** int32

deployCount

- **type:** integer
- **format:** int32

placementExpirationDateTime

- **type:** string

placementResultMessage

- **type:** string
- **description:** Details of placement during failure or success

constraintInfos

- **type:** array
- **description:** The constraints user specified when running reservation which limit where templates could be placed.
- – [**ReservationConstraintApiDTO**](#)

reservationDeployed

- **type:** boolean
- **description:** When true, the reservation will be included in the system and will keep utilizing the resources from host and storage until the corresponding virtual machine utilization starts to reflect on the historically computed utilization.

demandEntities

- **type:** array
- – [**DemandEntityInfoDTO**](#)

DemandReservationApiInputDTO

Description

Required Parameters

action

- **type:** string
- **description:** Action requested for the reservation
- **enum:** ['RESERVATION']

demandName

- **type:** string
- **description:** Name of the reservation
- **minLength:** 1
- **maxLength:** 2147483647

parameters

- **type:** array
- **description:** Reservation Parameters
- – **DemandReservationParametersDTO**
- **maxItems:** 1
- **minItems:** 1

Optional Parameters

reserveDateTime

- **type:** string
- **description:** Date to specify when to reserve the Demand

expireDateTime

- **type:** string
- **description:** Date to specify when the Demand request will expire, required if action = RESERVATION

deployDateTime

- **type:** string
- **description:** Date to specify when to deploy the Demand

DemandReservationParametersDTO

Description

Required Parameters

placementParameters

- **description:** Placement parameters
- **PlacementParametersDTO**

Optional Parameters

deploymentParameters

- **description:** Deployment parameters, required if action = DEPLOYMENT, RESERVATION
- **DeploymentParametersDTO**

DeploymentParametersDTO

Description

Optional Parameters

deploymentProfileID

- **type:** string
- **description:** Deployment Profile uuid

highAvailability

- **type:** boolean
- **description:** High availability

priority

- **type:** string
- **description:** Workload priority
- **enum:** ['LOW', 'NORMAL', 'MISSION_CRITICAL']

DeploymentProfileApiDTO

Description

Model to describe a Deployment Profile, including target and provider entity parameters

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

account

- **description:** Business account related to the Deployment Profile
- **BaseApiDTO**

deployParameters

- **type:** array
- **description:** Target and Provider parameters of the Deployment Profile
- – **DeploymentProfileTargetApiDTO**

DeploymentProfileParamApiDTO

Description

Provider-specific Deployment Profile parameters

Optional Parameters

parameterType

- **type:** string
- **description:** Parameter type. For vCenter, this can be a folder, osConfiguration, or image. For all other technologies, this must be an image.
- **enum:** ['image', 'folder', 'osConfiguration']

properties

- **type:** array
- **description:** A NameValueInputDTO describing the name and value of the parameter.
- – [NameValueInputDTO](#)

DeploymentProfileProviderApiDTO

Description

Deployment profile Provider properties

Optional Parameters

provider

- **description:** Provider UUID
- **BaseApiDTO**

parameters

- **type:** array
- **description:** A DeploymentProfileParamApiDTO describing the parameters for the provider entities
- – [DeploymentProfileParamApiDTO](#)

DeploymentProfileTargetApiDTO

Description

Deployment Profile Target properties

Optional Parameters

targetType

- **type:** string
- **description:** Target type for the deployment profile
- **enum:** ['vCenter', 'AWS', 'Azure', 'Softlayer']

providers

- **type:** array
- **description:** DeploymentProfileProviderApiInputDTO describing the provider entity parameters
- – [DeploymentProfileProviderApiDTO](#)

DesktopPoolEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

cloneType

- **type:** string
- **description:** Type of a clone provided by the DesktopPool
- **enum:** ['FULL', 'LINKED', 'INSTANT']

provisionType

- **type:** string
- **description:** How clones are provisioned in the DesktopPool
- **enum:** ['UPFRONT', 'ON_DEMAND']

assignmentType

- **type:** string
- **description:** Whether the same clone is assigned each time when user logs back in
- **enum:** ['PERSISTENT', 'DYNAMIC']

masterTemplateUuid

- **type:** string
- **description:** UUID of a master template that is used to create clones. Only one of master VM and master template can be set.

masterVirtualMachineUuid

- **type:** string
- **description:** UUID of a master virtual machine that is used to create clones. Only one of master VM and master template can be set.

masterVirtualMachineSnapshot

- **type:** string
- **description:** Name of the snapshot of a master virtual machine that is used to create clones.

getvCenterClusterName

- **type:** string
- **description:** Name of the vCenter cluster that this DesktopPool draws resources from.

vendorId

- **type:** string
- **description:** Vendor Identifier for the DesktopPool.

DetailDataApiDTO

Description

A single entity detail, represented as key-value pair

Required Parameters

key

- **type:** string

- **description:** Detail key

value

- **type:** string
- **description:** Detail value

Optional Parameters

critical

- **type:** boolean

DiscoveredEntityApiDTO

Description

Model to describe a discovered entity in the system

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

discoveredBy

- **description:** Target that discovered the entity
- **TargetApiDTO**

vendorIds

- **type:** object
- **description:** The mapping of target identifier to vendor-provided identity of this entity on the remote target
- **additionalProperties:** {'type': 'string'}

EntityActionsApiDTO

Description

Basic informations of an entity + actions

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

realtimeMarketReference

- **description:** In case of a Plan Market Entity, this contains the original entity from the Real Time Market
- **BaseApiDTO**

actions

- **type:** array
- **description:** List of actions for this entity
- – **ActionApiDTO**

EntityAspect

Description

Parent class for entity aspects

Required Parameters

type

- **type:** string

EntityCountRequestApiDTO

Description

A query used to fetch entity counts.

Optional Parameters

groupBy

- **type:** array
- **description:** Criteria to group the results by.
- **readOnly:** True
- – **type:** string
- **enum:** ['ENTITY_TYPE', 'ENVIRONMENT_TYPE']

EntityDetailsApiDTO

Description

Model to describe an entity with all its details

Required Parameters

uuid

- **type:** integer
- **format:** int64
- **description:** The internal UUID of the entity

Optional Parameters

details

- **type:** array
- **description:** A list of details, represented as key-value
- – [DetailDataApiDTO](#)

EntityMetadataRequestApiDTO

Description

A query used to fetch entity metadata.

Required Parameters

entityType

- **type:** string
- **description:** Entity type to fetch metadata for.
- **readOnly:** True
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

EntityPriceDTO

Description

Context-specific price. For example the base rate of a template in the context of certain business unit.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

price

- **type:** number
- **format:** float
- **description:** Price in the context of a related entity

EntityQueryApiDTO

Description

A query used to search topology entities.

Required Parameters**select**

- **description:** Information to be fetched for each entity.
- **readOnly:** True
- **[SelectEntityApiDTO](#)**

Optional Parameters**where**

- **description:** Conditions that each retrieved entity must satisfy.
- **readOnly:** True
- **[WhereApiDTO](#)**

pagination

- **description:** Pagination information.
- **readOnly:** True
- **[PaginationApiDTO](#)**

EntityStatsApiDTO

Description

Basic informations of an entity + statistics

Optional Parameters**uuid**

- **type:** string

displayName

- **type:** string

- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

realtimeMarketReference

- **description:** In case of a Plan Market Entity, this contains the original entity from the Real Time Market
- **BaseApiDTO**

stats

- **type:** array
- **description:** Collected monitoring statistics
- – StatSnapshotApiDTO

EntityUptimeApiDTO

Description

Model to describe the uptime of an entity

Optional Parameters

creationTimestamp

- **type:** integer
- **format:** int64
- **description:** The creation timestamp of the entity

uptimeDurationInMilliseconds

- **type:** integer
- **format:** int64
- **description:** Uptime duration in milliseconds for the total analyzed duration

totalDurationInMilliseconds

- **type:** integer
- **format:** int64
- **description:** Total analyzed duration in milliseconds for which uptime is calculated

uptimePercentage

- **type:** number
- **format:** double
- **description:** The uptime of the entity as a percentage

EnumFieldValueApiDTO

Description

Inherits From

This DTO inherits from [FieldValueApiDTO](#)

Required Parameters

value

- **type:** string
- **description:** The string representation of the value.
- **readOnly:** True

FailedResourceApiDTO

Description

A description of the resource that caused an entity to be unplaced

Required Parameters

commodity

- **description:** The commodity that caused the entity to be unplaced
- **[BaseCommodityApiDTO](#)**

requestedAmount

- **type:** number
- **format:** double
- **description:** The requested amount of the commodity that caused the entity to be unplaced

Optional Parameters

maxAvailable

- **type:** number
- **format:** double
- **description:** The maximum available amount of the requested commodity. Populated only if there are one or more entities selling the requested commodity.

FieldApiDTO

Description

A field of an entity or group.

Optional Parameters

fieldType

- **type:** string
- **description:** The kind of the field.

- **enum:** ['PRIMITIVE', 'COMMODITY', 'RELATED_ENTITY', 'RELATED_GROUP', 'RELATED_ACTION', 'AGGREGATE_COMMODITY', 'MEMBER']

FieldValueApiDTO

Description

A field of an entity or group with its value.

Required Parameters

field

- **description:** Field to compare.
- **readOnly:** True
- **FieldApiDTO**

valueType

- **type:** string
- **description:** Type of compared values.
- **readOnly:** True
- **enum:** ['NUMBER', 'TEXT', 'ENUM', 'INTEGER', 'BOOLEAN', 'MULTI_TEXT']

FieldValueTypeApiDTO

Description

A field of an entity or group associated with the type of its values.

Required Parameters

field

- **description:** Field for which information is presented.
- **readOnly:** True
- **FieldApiDTO**

valueType

- **type:** string
- **description:** Type of values of this field.
- **readOnly:** True
- **enum:** ['NUMBER', 'TEXT', 'ENUM', 'INTEGER', 'BOOLEAN', 'MULTI_TEXT']

Optional Parameters

allowableValues

- **type:** array
- **description:** Allowable string values for this field.
- **readOnly:** True
- – **type:** string

FilterApiDTO

Description

Model used to filter Groups or Entities, every filter is built using a filterType + expType + expVal

Required Parameters

caseSensitive

- **type:** boolean
- **description:** Whether the regex is case sensitive

expType

- **type:** string
- **description:** Type of comparator used while building a filter, the allowable values are 'EQ', 'NEQ', 'RXEQ', 'RXNEQ' for strings, 'EQ', 'NEQ', 'GT', 'LT', 'GTE', 'LTE' for numbers
- **enum:** ['EQ', 'NEQ', 'GT', 'LT', 'GTE', 'LTE', 'RXEQ', 'RXNEQ']

expVal

- **type:** string
- **description:** Regex to be searched for

filterType

- **type:** string
- **description:** Internal name for criterion such as pmsByName, pmsByDC, storageByPMCluster

Optional Parameters

entityType

- **type:** string
- **description:** The entity type which this filter should be applied on

singleLine

- **type:** boolean
- **description:** Whether the regex dot matches all characters including line break characters. Defaults to false.

GroupApiDTO

Description

Model to describe a Group: a collection of Entities. Subclasses include BillingFamilyApiDTO and ResourceGroupApiDTO.

Required Parameters

groupClassName

- **type:** string

groupType

- **type:** string
- **description:** The type of service entities comprising the group

isStatic

- **type:** boolean
- **description:** True if group is static

Optional Parameters**uuid**

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

membersCount

- **type:** integer
- **format:** int32
- **description:** Number of members of the Group

entitiesCount

- **type:** integer
- **format:** int32
- **description:** Number of entities of the Group

costPrice

- **type:** number
- **format:** float
- **description:** Cost of the Group per Hour: sum of the costs of the member entities

severity

- **type:** string
- **description:** Calculated using the highest severity of the member entities
- **enum:** ['UNKNOWN', 'NORMAL', 'MINOR', 'MAJOR', 'CRITICAL']

state

- **type:** string
- **description:** Calculated using the state of the member entities
- **enum:** ['UNKNOWN', 'ACTIVE']

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

remoteId

- **type:** string
- **description:** The identifier of this Group on the remote target, if applicable - [DEPRECATED - EOL: 8.6.1]

scope

- **type:** array
- **description:** Scope within which the criteria have to be applied to the list of specific entity type
- – **type:** string

logicalOperator

- **type:** string
- **description:** Logical operator to be applied across all the criteria used to create dynamic group. It can take values 'AND', 'OR', 'XOR'

criteriaList

- **type:** array
- **description:** Criteria list of elements, expression type, expression value, seType - needed to create a dynamic group
- – **FilterApiDTO**

memberUuidList

- **type:** array
- **description:** Uuid list for members of the group - if group is static
- – **type:** string

realtimeMarketReference

- **description:** In case of a Plan Market Group, this contains the original group from the Real Time Market
- **BaseApiDTO**

stats

- **type:** array
- **description:** Collected monitoring statistics
- – **StatSnapshotApiDTO**

temporary

- **type:** boolean
- **description:** The Group is only valid for a limited period of time, it will be removed automatically

activeEntitiesCount

- **type:** integer
- **format:** int32
- **description:** The active entities count of a group

cloudType

- **type:** string
- **description:** Type of the Cloud if environmentType = CLOUD.
- **enum:** ['AWS', 'AZURE', 'GCP', 'HYBRID', 'UNKNOWN']

source

- **description:** The Source of the Group
- **TargetApiDTO**

memberTypes

- **type:** array

- **description:** The types for immediate members of the group.
- – **type:** string

entityTypes

- **type:** array
- **description:** The types of entities contained in the group. This includes types of entities in nested levels of the group if the group is nested.
- – **type:** string

aspects

- **type:** object
- **description:** Additional info about the Group categorized as Aspects
- **additionalProperties:** {'\$ref': '#/definitions/EntityAspect'}

vendorIds

- **type:** object
- **description:** The mapping of target identifier to vendor-provided identity of this group, if the group is discovered
- **additionalProperties:** {'type': 'string'}

groupOrigin

- **type:** string
- **description:** Origin of entities and groups
- **enum:** ['DISCOVERED', 'USER', 'SYSTEM']

GroupCountRequestApiDTO

Description

A query used to fetch group counts.

Optional Parameters

groupBy

- **type:** array
- **description:** Criteria to group the results by.
- **readOnly:** True
- **uniqueItems:** True
- – **type:** string
- **enum:** ['GROUP_TYPE', 'ORIGIN']

GroupMetadataRequestApiDTO

Description

A query used to fetch group metadata.

Required Parameters

groupType

- **type:** string

- **description:** Group type to fetch metadata for.
- **readOnly:** True
- **enum:** ['Group', 'Resource', 'Cluster', 'VMCluster', 'StorageCluster', 'BillingFamily', 'NodePool']

GroupQueryApiDTO

Description

A query used to search groups.

Required Parameters

select

- **description:** Information to be fetched for each group.
- **readOnly:** True
- **[SelectGroupApiDTO](#)**

Optional Parameters

where

- **description:** Conditions that each retrieved group must satisfy.
- **readOnly:** True
- **[WhereApiDTO](#)**

pagination

- **description:** Pagination information.
- **readOnly:** True
- **[PaginationApiDTO](#)**

HealthCategoryResponseDTO

Description

A DTO to collect the aggregated health data for one health category.

Required Parameters

categoryDisplayName

- **type:** string
- **description:** The reported health category name.

categoryHealthState

- **type:** string
- **description:** The health state for the reported category.
- **enum:** ['CRITICAL', 'MAJOR', 'MINOR', 'NORMAL']

healthCategory

- **type:** string
- **description:** The reported health category.
- **enum:** ['TARGET', 'ACTION']

Optional Parameters

responseItems

- **type:** array
- **description:** A list of individual health response items for this health category.
- – [AggregatedHealthResponseDTO](#)

HttpProxyDTO

Description

Model to describe http proxy settings, like username, password, port number and host

Required Parameters

isProxyEnabled

- **type:** boolean
- **description:** Whether proxy is enabled or not

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

proxyHost

- **type:** string
- **description:** Proxy host

proxyPortNumber

- **type:** integer
- **format:** int32
- **description:** Proxy port number

userName

- **type:** string
- **description:** Proxy username

password

- **type:** string
- **description:** Proxy password

portNumber

- **type:** string
- **description:** Proxy port number - [DEPRECATED - EOL: 8.7.1 - Use: proxyPortNumber]

HttpServletResponse

Description

Optional Parameters

status

- **type:** integer
- **format:** int32

headerNames

- **type:** array
- – **type:** string

writer

- [PrintWriter](#)

characterEncoding

- **type:** string

bufferSize

- **type:** integer
- **format:** int32

committed

- **type:** boolean

locale

- [Locale](#)

contentType

- **type:** string

outputStream

- [ServletOutputStream](#)

IEntityDefinitionData

Description

Parent class for topology data definition

Required Parameters

definitionType

- **type:** string
- **enum:** ['MANUAL', 'AUTOMATED']

IManualConnectionsData

Description

Parent class for manual connections.

Required Parameters

connectionType

- **type:** string
- **enum:** ['DYNAMIC', 'STATIC', 'GROUP']

IncludedCouponsApiDTO

Description

Included RI/Coupon and related information in the scenario

Optional Parameters

includedCouponOidsList

- **type:** array
- **description:** User selected list of RIs to be included in plans
 - – **type:** integer
 - **format:** int64

iswhiteList

- **type:** boolean

InclusionConditionApiDTO

Description

Inherits From

This DTO inherits from [ConditionApiDTO](#)

Required Parameters

value

- **type:** array
- **description:** A set of strings. The value must belong to one of those.
- **readOnly:** True
 - – **type:** string

InputFieldApiDTO

Description

Basic information of an entity

Required Parameters

name

- **type:** string
- **description:** Name of the field, used for field identification.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

value

- **type:** string
- **description:** Field value. Used if field holds primitive value (String, number or boolean

defaultValue

- **type:** string
- **description:** Default value of the field

isMandatory

- **type:** boolean
- **description:** Whether the field is mandatory. Valid targets must have all the mandatory fields set.

isSecret

- **type:** boolean
- **description:** Whether the field is secret. This means, that field value is stored in an encrypted value and not shown in any logs.

isMultiline

- **type:** boolean
- **description:** Whether the field can have multiline values. Can be only true when the valueType field is set to STRING.

isTargetDisplayName

- **type:** boolean
- **description:** Whether the field is used as a target display name.

valueType

- **type:** string
- **description:** Type of the value this field holds
- **enum:** ['STRING', 'BOOLEAN', 'NUMERIC', 'LIST', 'OBJECT', 'GROUP_SCOPE']

specificValueType

- **type:** string
- **description:** A specific Type of the value that can't be described in valueType

description

- **type:** string
- **description:** Additional information about what the input to the field should be

verificationRegex

- **type:** string

- **description:** The regex pattern that needs to be satisfied for the input field text

groupProperties

- **type:** array
- **description:** Group scope structure, filled if this field represents group scope value
- – **type:** array
 - **type:** string

allowedValues

- **type:** array
- **description:** Potential values for this field. If nonempty, value must be one of the choices in the list.
- – **type:** string

dependencyKey

- **type:** string
- **description:** A key of a dependency account value field. If this value is not set, field is declared without any dependencies. If an annotated account value field has a dependency it means that it's presence is logically driven by the dependency field. This field is expected to be available ONLY when field specified by {@code dependencyKey} has value {@code dependencyValue}. If this field is not available because of unmet dependency, this field will not be validated and stored in target configuration data. If a dependency for this field is unmet value of this field will be null

dependencyValue

- **type:** string
- **example:** one|two|four
- **description:** Value of a field of account values referenced by {@code dependencyKey} to enable (activate) the annotated field. Value is specified using a regular expression. Specifying just a string will also work correctly. If a referenced account value field is a boolean field, only "true" or "false" are supported as values. If a referenced account value is an enumeration ({@code allowedValues} is specified) this value is only restricted to contain a subset of the allowed values united using a pipe {@code one|two|four}.

IntegerConditionApiDTO

Description

Inherits From

This DTO inherits from [ConditionApiDTO](#)

Required Parameters

value

- **type:** integer
- **format:** int64
- **description:** Value to compare against.
- **readOnly:** True

IntegerFieldValueApiDTO

Description

Inherits From

This DTO inherits from [FieldValueApiDTO](#)

Required Parameters

value

- **type:** integer
- **format:** int64
- **description:** The value.
- **readOnly:** True

Optional Parameters

units

- **type:** string
- **description:** Units of measurement.
- **readOnly:** True

LicenseApiDTO

Description

Model to describe properties of a license

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

licenseOwner

- **type:** string
- **description:** The owner of current license

email

- **type:** string
- **description:** The email of current license

customerId

- **type:** string
- **description:** The customer id

expirationDate

- **type:** string
- **description:** The expiration date of current license

features

- **type:** array
- **description:** List of features contained in current license
- **uniqueItems:** True
- – **type:** string

numLicensedEntities

- **type:** integer
- **format:** int32
- **description:** The number of licensed sockets

numInUseEntities

- **type:** integer
- **format:** int32
- **description:** The number of sockets in use

edition

- **type:** string
- **description:** The edition of the current license

filename

- **type:** string
- **description:** The name of the uploaded file

countedEntity

- **type:** string
- **description:** Indicates which entity type is counted with respect to licensing
- **enum:** ['VM', 'SOCKET']

maxReportEditorsCount

- **type:** integer
- **format:** int32
- **description:** Maximum number of report editors

expirationDateTime

- **type:** string
- **format:** date-time

errorReasons

- **type:** array
- **description:** Indicate why the license is invalid
- **uniqueItems:** True
- – **type:** string
 - **enum:** ['DUPLICATE_LICENSE', 'EXPIRED', 'INVALID_EMAIL', 'INVALID_CONTENT_TYPE', 'INVALID_LICENSE_KEY', 'INVALID_LICENSE_TYPE_CWOM_ONLY', 'INVALID_LICENSE_TYPE_FREEMIUM_NOT_ALLOWED', 'INVALID_FEATURE_SET', 'INCOMPATIBLE']

isExpired

- **type:** boolean
- **description:** Indicate if current license is expired

- **readOnly:** True

isValid

- **type:** boolean
- **description:** Indicate if current license is valid or not
- **readOnly:** True

Link

Description

Optional Parameters

rel

- **type:** string
- **xml:** {'attribute': True}

href

- **type:** string
- **xml:** {'attribute': True}

LoadChangesApiDTO

Description

Workload utilization changes in the scenario

Optional Parameters

baselineDate

- **type:** string
- **description:** Baseline date

peakBaselineList

- **type:** array
- **description:** List of peak baseline changes
- – [PeakBaselineApiDTO](#)

utilizationList

- **type:** array
- **description:** List of utilization changes
- – [UtilizationApiDTO](#)

maxUtilizationList

- **type:** array
- **description:** List of max utilization changes
- – [MaxUtilizationApiDTO](#)

overlayStatsList

- **type:** array
- **description:** List of stat changes to override the plan commodities values with the provided input

- – EntityStatsApiDTO

Locale

Description

Optional Parameters

script

- **type:** string

country

- **type:** string

variant

- **type:** string

extensionKeys

- **type:** array
- **uniqueItems:** True
- – **type:** string

unicodeLocaleAttributes

- **type:** array
- **uniqueItems:** True
- – **type:** string

unicodeLocaleKeys

- **type:** array
- **uniqueItems:** True
- – **type:** string

iso3Language

- **type:** string

iso3Country

- **type:** string

displayLanguage

- **type:** string

displayScript

- **type:** string

displayCountry

- **type:** string

displayVariant

- **type:** string

displayName

- **type:** string

language

- **type:** string

LogEntryApiDTO

Description

Basic information of an entity

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

logActionTime

- **type:** integer
- **format:** int64

targetSE

- **type:** string

targetUuid

- **type:** string

currentSE

- **type:** string

currentSEUuid

- **type:** string

newSE

- **type:** string

newSEUuid

- **type:** string

category

- **type:** string

subCategory

- **type:** string

description

- **type:** string

shortDescription

- **type:** string

state

- **type:** string

severity

- **type:** string

count

- **type:** integer
- **format:** int64

total

- **type:** integer
- **format:** int64

user

- **type:** string

type

- **type:** string

importance

- **type:** number
- **format:** float

reasonCommodity

- **type:** string
- **description:** The commodity that was the reason for the action - [DEPRECATED - EOL: 8.7.1 - Use: reasonCommodities]

reasonCommodities

- **type:** array
- **description:** The distinct set of commodities that were the reason for the action. Not all actions are driven by commodities. So its possible that this can be an empty list.
- **uniqueItems:** True
- – **type:** string

reasonCommodityRelationType

- **type:** string
- **description:** Relation type (bought/sold) of the reason commodity
- **enum:** ['sold', 'bought']

logDBId

- **type:** integer
- **format:** int64

LoggingApiDTO

Description

Model to describe the component logging level

Optional Parameters

componentLoggingLevel

- **type:** object
- **description:** A map from component name to logging level, component could be Discovery, Monitoring, Presentation, Abstraction, Analysis, Extension; logging levels could be INFO, WARN, DEBUG, TRACE
- **additionalProperties:** {'type': 'string', 'enum': ['FATAL', 'ERROR', 'WARN', 'INFO', 'DEBUG', 'TRACE', 'UNKNOWN']}

ManualDynamicConnections

Description

Inherits From

This DTO inherits from [IManualConnectionsData](#)

Optional Parameters

dynamicConnectionCriteria

- **type:** array
- **description:** Connection criteria to define dynamically connected entities.
- – [FilterApiDTO](#)

ManualEntityDefinitionData

Description

Inherits From

This DTO inherits from [IEntityDefinitionData](#)

Required Parameters

manualConnectionData

- **type:** object
- **description:** Entity connections set manually
- **additionalProperties:** {'\$ref': '#/definitions/IManualConnectionsData'}

ManualGroupConnections

Description

Inherits From

This DTO inherits from [IManualConnectionsData](#)

Required Parameters

connectedGroup

- **description:** Group for a connection.
- **BaseGroupApiDTO**

ManualStaticConnections

Description

Inherits From

This DTO inherits from [IManualConnectionsData](#)

Optional Parameters

staticConnections

- **type:** array
- **description:** Oids to be statically connected to the created entity
- – **type:** string

MarketApiDTO

Description

Model to describe a Market

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

state

- **type:** string
- **description:** State
- **enum:** ['CREATED', 'READY_TO_START', 'RUNNING', 'COPYING', 'SUCCEEDED', 'STOPPING', 'STOPPED', 'DELETING']

stateProgress

- **type:** integer
- **format:** int32
- **description:** State progress indicated by a percentage, used in RUNNING state

scenario

- **description:** Scenario used to create the Plan, only for Plan Market
- **ScenarioApiDTO**

saved

- **type:** boolean
- **description:** Shows if a Plan Market is saved

unplacedEntities

- **type:** boolean
- **description:** Unplaced entities, shows if there are entities that could not be placed in the Plan Market

runDate

- **type:** string
- **description:** Shows when a Plan Market started running

runCompleteDate

- **type:** string
- **description:** Shows when a Plan Market was completed

violations

- **type:** array
- **description:** Violations generated in a Plan Market
- – **ServiceEntityApiDTO**

relatedPlanMarkets

- **type:** array
- **description:** Related Plan Markets generated by particular Scenarios
- – **MarketApiDTO**

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['HYBRID', 'CLOUD', 'ONPREM']

planDestination

- **description:** Plan destination where the plan results would be stored, only for Plan Market.
- **BaseApiDTO**

MasterImageEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

displayName

- **type:** string
- **description:** DisplayName of the masterImage used to create new VMs

numVcpus

- **type:** integer
- **format:** int32
- **description:** The number of vCPUs allocated to each VM generated from the master image

mem

- **type:** number
- **format:** float
- **description:** The amount of Mem allocated to each VM generated from the master image

storage

- **type:** number
- **format:** float
- **description:** The amount of Storage allocated to each VM generated from the master image

MaxUtilizationApiDTO

Description

Model to describe a max utilization change in the scenario

Optional Parameters

projectionDay

- **type:** integer
- **format:** int32
- **description:** Projection day, indicate when to apply the change

target

- **description:** Target of the change, entity or group. If empty, assumes global scope
- **BaseApiDTO**

maxPercentage

- **type:** integer
- **format:** int32
- **description:** Max utilization threshold percentage change

selectedEntityType

- **type:** string
- **description:** Type of entity to select in global scope configuration

globalScope

- **type:** boolean

MemberFieldApiDTO

Description

Inherits From

This DTO inherits from [FieldApiDTO](#)

Required Parameters

property

- **type:** string
- **description:** The property of interest.
- **readOnly:** True
- **enum:** ['COUNT']

Optional Parameters

entityType

- **type:** string
- **description:** Restricts the property to entities of this type.
- **readOnly:** True
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

direct

- **type:** boolean
- **description:** Whether this field refers to direct or indirect members (default = direct).
- **readOnly:** True

MigrateObjectApiDTO

Description

Model to describe a replace change in the scenario

Optional Parameters

projectionDay

- **type:** integer
- **format:** int32
- **description:** Projection day, indicate when to apply the change

source

- **description:** Source of the migration, entity or group - [DEPRECATED - Use: sources]
- **BaseApiDTO**

destination

- **description:** Destination of the migration - [DEPRECATED - Use: destinations]
- **BaseApiDTO**

sources

- **type:** array
- **description:** Sources of the migration, entities or groups.
- – **BaseApiDTO**

destinations

- **type:** array
- **description:** Destinations of the migration, entities or groups.
- – **BaseApiDTO**

destinationEntityType

- **type:** string
- **description:** Entity type of migration destination, default is VirtualMachine. Case 1, migration source VirtualMachine: destination entity must be VirtualMachine. Case 2, migration source Database Server: destination entity can be VirtualMachine or DatabaseServer.
- **enum:** ['VirtualMachine', 'DatabaseServer']

removeNonMigratingWorkloads

- **type:** boolean
- **description:** If true, remove the existing Virtual Machines, Databases and Database Servers from the scope that are not migrating, so that only the newly migrated entities are included in the plan results.

MultiTextFieldValueApiDTO

Description

Inherits From

This DTO inherits from [FieldValueApiDTO](#)

Required Parameters

value

- **type:** array
- **description:** The values associated with the field.
- **readOnly:** True
- – **type:** string

NameValueInputDTO

Description

Deployment Profile provider parameters

Optional Parameters

name

- **type:** string
- **description:** Parameter type. For vCenter, this can be a name or id. For all other target types, this must be an id.
- **enum:** ['name', 'id']

value

- **type:** string

NumberConditionApiDTO

Description

Inherits From

This DTO inherits from [ConditionApiDTO](#)

Required Parameters

value

- **type:** number
- **format:** double
- **description:** Value to compare against.
- **readOnly:** True

NumberFieldValueApiDTO

Description

Inherits From

This DTO inherits from [FieldValueApiDTO](#)

Required Parameters

value

- **type:** number
- **format:** double
- **description:** The value.
- **readOnly:** True

Optional Parameters

units

- **type:** string
- **description:** Units of measurement.
- **readOnly:** True

OnPremResizeActionDetailsApiDTO

Description

Inherits From

This DTO inherits from [ActionDetailsApiDTO](#)

Optional Parameters

vcpuBefore

- **type:** integer
- **format:** int32
- **description:** vCPUs before the change

vcpuAfter

- **type:** integer
- **format:** int32
- **description:** vCPUs after the change

socketsBefore

- **type:** integer
- **format:** int32
- **description:** sockets before the change

socketsAfter

- **type:** integer
- **format:** int32
- **description:** sockets after the change

coresPerSocketBefore

- **type:** integer
- **format:** int32
- **description:** cores per socket before the change

coresPerSocketAfter

- **type:** integer
- **format:** int32
- **description:** cores per socket after the change

subType

- **type:** string

OrderByApiDTO

Description

A field to order results by.

Required Parameters

field

- **description:** The field to order by.
- **readOnly:** True
- **FieldApiDTO**

Optional Parameters

ascending

- **type:** boolean
- **description:** Whether the order is ascending (defaults to false).
- **readOnly:** True

PMDiskAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

diskCapacity

- **type:** integer
- **format:** int64
- **description:** Disk Capacity

diskRole

- **type:** string
- **description:** Disk Role
- **enum:** ['CAPACITY', 'CACHE']

PMDiskGroupAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

disks

- **type:** array
- **description:** Disks
- – [PMDiskAspectApiDTO](#)

PMEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

diskGroups

- **type:** array
- **description:** Disk Groups
- – [PMDiskGroupAspectApiDTO](#)

dedicatedFailoverHost

- **type:** boolean
- **description:** If true, this host is a failover host.

cpuModel

- **type:** string
- **example:** Intel(R) Xeon(R) CPU E5-2670 0 @ 2.60GHz
- **description:** The CPU model of the host

connectedNetworks

- **type:** array
- **example:** Broadcom BCM5708C NetXtreme II GigE
- **description:** Connected Networks
- – **type:** string

automationLevel

- **type:** string
- **example:** Fully Automated
- **description:** Vendor provided automation level
- **enum:** ['FULLY_AUTOMATED', 'PARTIALLY_AUTOMATED', 'NOT_AUTOMATED', 'DISABLED']

migrationLevel

- **type:** string
- **example:** Conservative
- **description:** Vendor provided migration level

processorPools

- **type:** array

- – **type:** string

PaginationApiDTO

Description

Pagination parameters.

Optional Parameters

orderBy

- **type:** array
- **description:** Order by these fields.
- **readOnly:** True
- – [OrderByApiDTO](#)

cursor

- **type:** string
- **description:** Cursor for the next batch.
- **readOnly:** True

limit

- **type:** integer
- **format:** int32
- **description:** Maximum number of records to fetch.
- **readOnly:** True

PatchedTargetDataApiDTO

Description

Model to describe a patched target data.

Required Parameters

patchedFields

- **type:** array
- **description:** Patched target fields.
- – [PatchedTargetFieldApiDTO](#)

probeType

- **type:** string
- **description:** Probe type of the patched target.

PatchedTargetFieldApiDTO

Description

Model to describe a field in patched target data.

Optional Parameters

fieldName

- **type:** string
- **description:** Patched field name.

fieldValue

- **type:** string
- **description:** Patched field value.

PeakBaselineApiDTO

Description

Model to describe a peak baseline change in the scenario

Optional Parameters

date

- **type:** string
- **description:** Date of the utilization peak

target

- **description:** Target of the change
- **BaseApiDTO**

PlacementInfoDTO

Description

Optional Parameters

computeResources

- **type:** array
- **description:** Compute resources that the reservation is placed in
- – **ResourceApiDTO**

storageResources

- **type:** array
- **description:** Storage resources that the reservation is placed in
- – **ResourceApiDTO**

networkResources

- **type:** array
- **description:** Network resources that the reservation is placed in
- – **ResourceApiDTO**

failureInfos

- **type:** array
- **description:** Details about why the reservation failed. This will only be populated if the reservation failed.

- – [ReservationFailureInfoDTO](#)

invalidInfo

- **description:** Details about why the reservation is invalid. This will only be populated if the reservation is invalid.
- [ReservationInvalidInfoApiDTO](#)

PlacementOptionApiDTO

Description

Model to describe the property of provider options.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

constraintType

- **type:** string
- **description:** constraint type, if a commodity is AccessCommodity, then the class name of that commodity is a constraint type
- **enum:** ['ApplicationCommodity', 'ClusterCommodity', 'DataCenterCommodity', 'DatastoreCommodity etc']

scope

- **description:** scope or placement policy
- [BaseApiDTO](#)

target

- **description:** for placement policy, if it's an user placement policy is null.
- [TargetApiDTO](#)

numPotentialEntities

- **type:** integer
- **format:** int32
- **description:** example: other VMs, which buys this constraint but not on this host

key

- **type:** string
- **description:** commodity key, this information is needed when trying to retrieve the interaction of providers or consumers

currentEntities

- **type:** array

- **description:** for consumers only. example: VMs, which are currently on this host per constraint they are buying
- – [ServiceEntityApiDTO](#)

PlacementOptionApiInputDTO

Description

Model to describe the property of provider options.

Optional Parameters

constraintType

- **type:** string
- **description:** constraint type, if a commodity is AccessCommodity, then the class name of that commodity is a constraint type
- **enum:** ['ApplicationCommodity', 'ClusterCommodity', 'DataCenterCommodity', 'DatastoreCommodity etc']

key

- **type:** string
- **description:** commodity key, this information is needed when trying to retrieve the intersection of providers or consumers

PlacementParametersDTO

Description

Required Parameters

count

- **type:** integer
- **format:** int32
- **description:** Number of Virtual Machines to Place

Optional Parameters

templateID

- **type:** string
- **description:** Template Uuid used for the Placement

entityNames

- **type:** array
- **description:** Name of the Placed Virtual Machine
- – **type:** string

constraintIDs

- **type:** array
- **description:** List of uuids that will define the constraints that new VMs should be compliant to, allowed uuids are: Cluster, Datacenter, VirtualDataCenter, Network, Placement Policy. The possible providers are the intersection of all constraints passed.

- **uniqueItems:** True
- – **type:** string

geographicRedundancy

- **type:** boolean
- **description:** Enable Geographic Redundancy

PlanDestinationApiDTO

Description

Model to describe a plan destination. A plan destination is an external destination where plan results can be uploaded.

Required Parameters

businessUnit

- **description:** Business account to plan destination.
- **BaseApiDTO**

exportDescription

- **type:** string
- **description:** Plan export description message on this plan destination.

exportProgressPercentage

- **type:** integer
- **format:** int32
- **description:** Plan export progress percentage on this plan destination.

exportState

- **type:** string
- **description:** Plan export state on this plan destination.
- **enum:** ['NONE', 'REJECTED', 'IN_PROGRESS', 'SUCCEEDED', 'FAILED']

hasExportedData

- **type:** boolean
- **description:** Boolean, true if this plan destination has uploaded data.

market

- **description:** Plan market currently uploaded to plan destination.
- **BaseApiDTO**

numErrors

- **type:** integer
- **format:** int32
- **description:** Number of errors on the plan destination.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

PolicyApiDTO

Description

Model to describe a Workload policy, used to manage the entities in the Environment. e.g. Restrict the number of VMs that can use a given datastore, Limit VM mobility by restricting a collection of VMs to a specified cluster or group of hosts, Expand VM mobility by merging a number of clusters, Keep workload running on hosts that have the required licenses

Required Parameters

type

- **type:** string
- **description:** Placement Policy Type
- **enum:** ['AT_MOST_N', 'BIND_TO_GROUP', 'BIND_TO_COMPLEMENTARY_GROUP', 'MUST_RUN_TOGETHER', 'AT_MOST_N_BOUND', 'MERGE', 'BIND_TO_GROUP_AND_LICENSE', 'MUST_NOT_RUN_TOGETHER', 'EXCLUSIVE_BIND_TO_GROUP']

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

name

- **type:** string
- **description:** Name of the policy

enabled

- **type:** boolean
- **description:** Shows if the policy is enabled

capacity

- **type:** integer
- **format:** int32
- **description:** Indicate the max workload entities at the same time per placement entites, used when type is AT_MOST_N_BOUND

commodityType

- **type:** string
- **description:** Commodity type used for the policy

mergeType

- **type:** string
- **description:** Type of Group that is merged, used only when type is MERGE
- **enum:** ['Cluster', 'StorageCluster', 'DataCenter', 'DesktopPool']

consumerGroup

- **description:** Consumer Group, used when type is any but MERGE
- **BaseApiDTO**

providerGroup

- **description:** Provider Group, used when type is any but MERGE
- **BaseApiDTO**

mergeGroups

- **type:** array
- **description:** List of Groups to merge, used when type is MERGE
- – **BaseApiDTO**

providerEntityType

- **type:** string
- **description:** The entity type for the provider. This property is only applicable when policy type is set to MUST_RUN_TOGETHER or MUST_NOT_RUN_TOGETHER. When policy type is set to MUST_RUN_TOGETHER or MUST_NOT_RUN_TOGETHER, this field should be set with type of provider where members of consumer group must run or must not run together on it depending on the policy type.
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

PolicyApiInputDTO

Description

Model to describe a Placement Policy

Required Parameters

policyName

- **type:** string
- **description:** Name of the policy

type

- **type:** string
- **description:** Placement Policy Type
- **enum:** ['AT_MOST_N', 'BIND_TO_GROUP', 'BIND_TO_COMPLEMENTARY_GROUP', 'MUST_RUN_TOGETHER', 'AT_MOST_N_BOUND', 'MERGE', 'BIND_TO_GROUP_AND_LICENSE', 'MUST_NOT_RUN_TOGETHER', 'EXCLUSIVE_BIND_TO_GROUP']

Optional Parameters

sellerUuid

- **type:** string
- **description:** Uuid of the provider Group in a Placement Policy

buyerUuid

- **type:** string
- **description:** Uuid of the consumer Group in a Placement Policy

mergeUuids

- **type:** array
- **description:** Uuids of the Groups in a Merge Policy
- – **type:** string

mergeType

- **type:** string
- **description:** Group Type in a Merge Policy
- **enum:** ['Cluster', 'StorageCluster', 'DataCenter', 'DesktopPool']

capacity

- **type:** integer
- **format:** int32
- **description:** For an AT_MOST_N or AT_MOST_N_BOUND policy, the number of consumers to allow on a provider entity

enabled

- **type:** boolean
- **description:** Whether to enable the policy

providerEntityType

- **type:** string
- **description:** The entity type for the provider. This property is only applicable when the policy type is set to MUST_RUN_TOGETHER or MUST_NOT_RUN_TOGETHER. This field is set with the provider type (for example, PhysicalMachine) the policy should respect.
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

PortChannelApiDTO

Description

Model to describe a Port Channel

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

capacity

- **description:** Capacity values
- [StatValueApiDTO](#)

values

- **description:** Contains Average, Min, Max, Total
- [StatValueApiDTO](#)

units

- **type:** string
- **description:** Units, used for Commodities stats. E.G. \$/h

ports

- **type:** array
- **description:** List of ports in the channel
- – [StatApiDTO](#)

filters

- **type:** array
- **description:** describe the grouping options used to generate the output
- – [StatFilterApiDTO](#)

PortsAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

portChannels

- **type:** array
- **description:** Port Channels
- – [PortChannelApiDTO](#)

ports

- **type:** array
- **description:** Independent ports
- – [StatApiDTO](#)

PriceAdjustmentDTO

Description

Optional Parameters

type

- **type:** string
- **enum:** ['DISCOUNT', 'INCREASE']

value

- **type:** number
- **format:** float

PrimitiveFieldApiDTO

Description

Inherits From

This DTO inherits from [FieldApiDTO](#)

Required Parameters

fieldName

- **type:** string
- **description:** The name of the primitive field.
- **readOnly:** True

PrintWriter

Description

This is an unspecified object.

ProbeApiDTO

Description

Model to describe a probe.

Required Parameters

category

- **type:** string
- **description:** Probe category.

id

- **type:** integer
- **format:** int64
- **description:** Probe id.

type

- **type:** string
- **description:** Probe type.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

error

- **type:** string
- **description:** Unexpected error while collecting probe information

ProbePropertyApiDTO

Description

Model to describe a probe property

Required Parameters

name

- **type:** string
- **description:** Probe property name.

value

- **type:** string
- **description:** Probe property value.

Optional Parameters

probeId

- **type:** integer
- **format:** int64
- **description:** Probe id.

targetId

- **type:** integer
- **format:** int64
- **description:** Target id.

ProbePropertyNameValuePairApiDTO

Description

Model to describe a name/value pair for probe properties.

Required Parameters

name

- **type:** string
- **description:** Probe property name.

value

- **type:** string
- **description:** Probe property value.

ProductCapabilityDTO

Description

Model to describe Product Capability information.

Optional Parameters

deploymentMode

- **type:** string
- **description:** Deployment mode, affects hiding / showing multiple UI views, options
- **enum:** ['SAAS', 'SERVER']

searchApiEnabled

- **type:** boolean
- **description:** Controls use of new search api

jdbcHttpSessionEnabled

- **type:** boolean
- **description:** Controls use of JDBC persistent HTTP Session

reportingEnabled

- **type:** boolean

ProductVersionDTO

Description

Contains version information about the running Turbonomic instance.

Optional Parameters

versionInfo

- **type:** string
- **example:** "versionInfo": "Turbonomic Operations Manager
8.0.1-SNAPSHOT (Build \"20200922092548000\") \"2020-09-22
20:10:04\"\\n\\n\\naction-orchestrator: 8.0.1-SNAPSHOT\\napi: 8.0.1-SNAPSHOT\\nauth:
8.0.1-SNAPSHOT\\ncost: 8.0.1-SNAPSHOT\\nexttractor: 8.0.1-SNAPSHOT\\ngroup:
8.0.1-SNAPSHOT\\nhistory: 8.0.1-SNAPSHOT\\nmarket: 8.0.1-SNAPSHOT\\nmediation-
actionscrip: 8.0.1-SNAPSHOT\\nmediation-appdynamics: 8.0.1-SNAPSHOT\\nmediation-
appinsights: 8.0.1-SNAPSHOT\\nmediation-aws: 8.0.1-SNAPSHOT\\nmediation-
awsbilling: 8.0.1-SNAPSHOT\\nmediation-awscost: 8.0.1-SNAPSHOT\\nmediation-
azure: 8.0.1-SNAPSHOT\\nmediation-azurecost: 8.0.1-SNAPSHOT\\nmediation-azureea:
8.0.1-SNAPSHOT\\nmediation-azuresp: 8.0.1-SNAPSHOT\\nmediation-azurevolumes:
8.0.1-SNAPSHOT\\nmediation-dynatrace: 8.0.1-SNAPSHOT\\nmediation-hpe3par:
8.0.1-SNAPSHOT\\nmediation-hyperv: 8.0.1-SNAPSHOT\\nmediation-netapp: 8.0.1-
SNAPSHOT\\nmediation-nutanix: 8.0.1-SNAPSHOT\\nmediation-oneview: 8.0.1-
SNAPSHOT\\nmediation-pure: 8.0.1-SNAPSHOT\\nmediation-ucs: 8.0.1-SNAPSHOT\\nmediation-
vcenter: 8.0.1-SNAPSHOT\\nmediation-vcenterbrowsing: 8.0.1-SNAPSHOT\\nmediation-
vmax: 8.0.1-SNAPSHOT\\nmediation-vmware: 8.0.1-SNAPSHOT\\nplan-orchestrator: 8.0.1-
SNAPSHOT\\nrepository: 8.0.1-SNAPSHOT\\ntopology-processor: 8.0.1-SNAPSHOT"
- **description:** A multi-line string describing the version information, including that of the various internal components.

version

- **type:** string
- **example:** 8.0.1-SNAPSHOT
- **description:** The Operations Manager product version, including major and minor versions

build

- **type:** string
- **example:** 20200922211058775
- **description:** The build number associated with this deployment.

commit

- **type:** string
- **example:** 1183dd2
- **description:** The commit associated with this deployment.

branch

- **type:** string
- **example:** 8.0.1
- **description:** The branch associated with this deployment.

buildUser

- **type:** string
- **description:** The build user - [DEPRECATED - EOL: 8.6.1]

gitDescription

- **type:** string
- **example:** 1183dd2bb8ebca3dbcaf708e0c323cab7b8e352
- **description:** Specific source control information associated with this deployment.

updates

- **type:** string
- **description:** Description of available updates--not yet implemented in XL.

marketVersion

- **type:** integer
- **format:** int32
- **example:** 2
- **description:** The version of the market

apiVersion

- **type:** string
- **example:** 3.1
- **description:** The version of the REST API.

PurchaseProfileDTO

Description

Model to describe a set of preferences for purchasing RIs

Required Parameters

cloudType

- **type:** string
- **description:** Cloud type
- **enum:** ['AWS', 'AZURE', 'GCP', 'HYBRID', 'UNKNOWN']

paymentOption

- **type:** string
- **description:** Preferred payment option
- **enum:** ['ALL_UPFRONT', 'PARTIAL_UPFRONT', 'NO_UPFRONT']

reservedInstanceType

- **type:** string
- **description:** Preferred offering class (Standard or Convertible)
- **enum:** ['STANDARD', 'CONVERTIBLE']

termYears

- **type:** integer
- **format:** int32
- **description:** Number of years in preferred term

QueryInputApiDTO

Description

Model to describe an input query

Required Parameters

query

- **type:** string
- **description:** Query string. The format of this depends on the QueryType chosen. For example, for a REGEX QueryType, this should be a regular expression.

type

- **type:** string
- **description:** Query type
- **enum:** ['EXACT', 'REGEX', 'CONTAINS']

Optional Parameters

caseSensitive

- **type:** boolean
- **description:** If true, the query string will match case-sensitivity. This field is only used when QueryType is not REGEX.

RIBuyActionDetailsApiDTO

Description

Inherits From

This DTO inherits from [ActionDetailsApiDTO](#)

Optional Parameters

estimatedOnDemandCost

- **type:** number
- **format:** float

estimatedRICoverage

- **type:** number
- **format:** float

historicalDemandDataset

- **type:** array
- – [StatSnapshotApiDTO](#)

subType

- **type:** string

RIPurchaseProfilesSettingApiDTO

Description

Inherits From

This DTO inherits from [SettingApiDTO](#)

Required Parameters

value

- **description:** Value of the RI Purchase Profiles of type [ReservedInstancePurchaseSettingsDTO](#).
- **[ReservedInstancePurchaseSettingsDTO](#)**

Optional Parameters

defaultValue

- **description:** Default value before any change
- **readOnly:** True
- **[ReservedInstancePurchaseSettingsDTO](#)**

RangeApiDTO

Description

Model to describe the Range of a Value in the Settings

Optional Parameters

step

- **type:** number
- **format:** double
- **description:** The Step scale factor of the slider

labels

- **type:** array
- **description:** Labels to show in the values of the slider
- – **type:** string

customStepValues

- **type:** array
- **description:** Custom step values when the slider step is not constant - [DEPRECATED - Use: [stepValues](#)]
- – **type:** integer
- **format:** int32

stepValues

- **type:** array
- **description:** Custom step values when the slider step is not constant
- – **type:** number

- **format:** float

RangeInputApiDTO

Description

Model to describe an input range. Either minValue or maxValue needs to be defined.

Optional Parameters

minValue

- **type:** number
- **format:** float
- **description:** Minimum value of the input range

maxValue

- **type:** number
- **format:** float
- **description:** Maximum value of the input range

RateCardApiDTO

Description

Model to describe a ratecard.

Required Parameters

info

- **description:** List of business unit UUID's related to this rate card.
- [RateCardInfoApiDTO](#)

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

type

- **type:** string
- **description:** Type of rate card", example = "AWS, Azure"
- **enum:** ['AWS', 'AZURE', 'GCP', 'HYBRID', 'UNKNOWN']

related

- **description:** List of business units related to this rate card.
- [RateCardRelatedApiDTO](#)

validation

- **description:** Rate card validation.
- **RateCardValidationApiDTO**

valid

- **type:** boolean

default

- **type:** boolean

fileName

- **type:** string

RateCardInfoApiDTO

Description

Model to describe the attributes of a rate card.

Required Parameters**businessUnitsIds**

- **type:** array
- **description:** List of business units associated to this rate card.
- – **type:** string

RateCardRelatedApiDTO

Description

Model to describe the related business units of this ratecard.

Optional Parameters**businessUnits**

- **type:** array
- **description:** List of business units related to the ratecard
- – **BusinessUnitApiDTO**

RateCardValidationApiDTO

Description

Model to validate the RateCard

Optional Parameters**name**

- **type:** string
- **description:** Name of the rate card file

status

- **type:** string

- **example:** VALID, INVALID
- **description:** Validation Status
- **enum:** ['VALID', 'INVALID']

message

- **type:** string
- **example:** Validation was successful, Validation failed
- **description:** Reason for validation failure or success.

Recommendation

Description

A DTO for a single recommendation to an error.

Required Parameters

description

- **type:** string
- **description:** The recommended user action to investigate/mitigate the problem.

errorType

- **type:** string
- **description:** The problem this recommendation is produced for.

ReconfigureActionDetailsApiDTO

Description

Inherits From

This DTO inherits from [ActionDetailsApiDTO](#)

Optional Parameters

vcpuBefore

- **type:** integer
- **format:** int32
- **description:** vCPUs before the change

vcpuAfter

- **type:** integer
- **format:** int32
- **description:** vCPUs after the change

socketsBefore

- **type:** integer
- **format:** int32
- **description:** sockets before the change

socketsAfter

- **type:** integer
- **format:** int32
- **description:** sockets after the change

coresPerSocketBefore

- **type:** integer
- **format:** int32
- **description:** cores per socket before the change

coresPerSocketAfter

- **type:** integer
- **format:** int32
- **description:** cores per socket after the change

RecurrenceApiDTO

Description

Model to describe the Schedule for a Settings Policy

Required Parameters

type

- **type:** string
- **description:** Type of the recurrence, Enum: DAILY, WEEKLY, MONTHLY
- **enum:** ['DAILY', 'WEEKLY', 'MONTHLY']

Optional Parameters

daysOfWeek

- **type:** array
- **description:** The day of week that the recurrence will occur. Required if the type of recurrence is WEEKLY, or if the type is MONTHLY and a week for the monthly recurrence has been set.
- – **type:** string
 - **enum:** ['Sun', 'Mon', 'Tue', 'Wed', 'Thu', 'Fri', 'Sat']

daysOfMonth

- **type:** array
- **description:** When recurrence type is MONTHLY, the date to apply the monthly recurrence
- – **type:** integer
 - **format:** int32

weekOfTheMonth

- **type:** array
- **description:** When recurrence type is MONTHLY, which week of the month to apply the recurrence. A value of -1 indicates last week, 0 indicates this week, and so on.
- – **type:** integer
 - **format:** int32

interval

- **type:** integer
- **format:** int32
- **description:** Frequency of the recurrence based on the recurrence type. For example, an interval of '2' with a recurrence type of MONTHLY will occur every two months.

RegionAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

latitude

- **type:** number
- **format:** double
- **description:** The latitude of the region used along with longitude to determine physical location.

longitude

- **type:** number
- **format:** double
- **description:** The longitude of the region used along with latitude to determine physical location.

numWorkloads

- **type:** integer
- **format:** int32
- **description:** Number of workloads (VMs, databases, etc.) in this region.

RelatedActionApiDTO

Description

Model to describe the relationship between two actions

Optional Parameters

action

- **description:** The basic action DTO for the related action
- **[BasicActionApiDTO](#)**

actionRelationType

- **type:** string
- **description:** Action relation type
- **enum:** ['BLOCKED_BY', 'BLOCKING', 'CAUSED_BY', 'CAUSING']

RelatedEntityFieldApiDTO

Description

Inherits From

This DTO inherits from [FieldApiDTO](#)

Required Parameters

property

- **type:** string
- **description:** The related entity property of interest.
- **readOnly:** True
- **enum:** ['NAMES', 'COUNT']

relatedEntityType

- **type:** string
- **description:** The type of related entities of interest.
- **readOnly:** True
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

RelatedGroupFieldApiDTO

Description

Inherits From

This DTO inherits from [FieldApiDTO](#)

Required Parameters

property

- **type:** string
- **description:** The related group property of interest.
- **readOnly:** True
- **enum:** ['NAMES', 'COUNT']

relatedGroupType

- **type:** string
- **description:** The type of related groups of interest.
- **readOnly:** True

- **enum:** ['Group', 'Resource', 'Cluster', 'VMCluster', 'StorageCluster', 'BillingFamily', 'NodePool']

RelievePressureObjectApiDTO

Description

Model to describe a relieve pressure change in the scenario: minimum amount of Actions Moves that will relieve the pressure on the over-utilized clusters

Optional Parameters

projectionDay

- **type:** integer
- **format:** int32
- **description:** Projection day, indicate when to apply the change

sources

- **type:** array
- **description:** Sources of the change, List of Clusters that are overloaded
- – **BaseApiDTO**

destinations

- **type:** array
- **description:** Destinations of the change, List of Clusters where VMs can move to
- – **BaseApiDTO**

RemoveConstraintApiDTO

Description

Model to describe a constraint change in the scenario

Optional Parameters

constraintType

- **type:** string
- **description:** Type of the constraint to remove. To ignore all constraints - use AllCommodities. This will ignore all constraints not just Network/Cluster/StorageCluster/DC. GlobalIgnoreConstraint - deprecated - use AllCommodities instead.
- **enum:** ['DataCenterCommodity', 'ClusterCommodity', 'NetworkCommodity', 'DatastoreCommodity', 'StorageClusterCommodity', 'GlobalIgnoreConstraint', 'AllCommodities']

projectionDay

- **type:** integer
- **format:** int32
- **description:** Projection day, indicate when to apply the change

target

- **description:** Target of the change, when not provided change applied to plan scope
- **BaseApiDTO**

targetEntityType

- **type:** string
- **description:** EntityType to target with constraint configuration
- **enum:** ['VirtualMachine', 'Container', 'ContainerPod']

RemoveObjectApiDTO

Description

Model to describe a remove change in the scenario

Optional Parameters

projectionDay

- **type:** integer
- **format:** int32
- **description:** Projection day, indicate when to apply the change

targetEntityType

- **type:** string
- **description:** Type of entity to remove from group target

target

- **description:** Target of the change, entity or group
- **BaseApiDTO**

ReplaceObjectApiDTO

Description

Model to describe a migration change in the scenario

Optional Parameters

projectionDay

- **type:** integer
- **format:** int32
- **description:** Projection day, indicate when to apply the change

target

- **description:** Target of the change, entity or group
- **BaseApiDTO**

template

- **description:** Template used for the replace
- **BaseApiDTO**

targetEntityType

- **type:** string
- **description:** Type of entity to remove from group target

ReservationConstraintApiDTO

Description

The constraints user specified when running reservation which limit where templates could be placed.

Required Parameters

constraintType

- **type:** string
- **description:** Type of constraint
- **enum:** ['CLUSTER', 'DATA_CENTER', 'VIRTUAL_DATA_CENTER', 'POLICY', 'NETWORK']

uuid

- **type:** string
- **description:** UUID of the constraint

Optional Parameters

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

ReservationFailureInfoDTO

Description

Failure information when reservation fails

Required Parameters

closestSeller

- **description:** provider that came closest to meeting the requirements
- **BaseApiDTO**

closestSellerCluster

- **description:** Closest provider's cluster information
- **BaseApiDTO**

maxQuantityAvailable

- **type:** number
- **format:** double
- **description:** Quantity of resource available on closestSeller

quantityRequested

- **type:** number
- **format:** double
- **description:** Quantity of resource requested

resource

- **type:** string
- **description:** Most constrained resource

timespan

- **type:** string
- **description:** Failure is in historical or current
- **enum:** ['HISTORICAL', 'CURRENT', 'PROJECTED', 'PLAN_SOURCE', 'PLAN_PROJECTED']

Optional Parameters

units

- **type:** string
- **description:** Units for the resource

ReservationInvalidInfoApiDTO

Description

The reason the reservation is invalid

Optional Parameters

invalidReason

- **type:** string
- **description:** The reason why the reservation is invalid
- **enum:** ['MARKET_CONNECTIVITY_ERROR', 'MARKET_NOT_READY', 'INVALID_CONSTRAINTS']

ReservedInstanceApiDTO

Description

Model to describe a Reserved Instance

Required Parameters

cloudType

- **type:** string
- **description:** Cloud Type
- **enum:** ['AWS', 'AZURE', 'GCP', 'HYBRID', 'UNKNOWN']

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

template

- **description:** Related template
- **BaseApiDTO**

platform

- **type:** string
- **description:** Platform name
- **enum:** ['UNKNOWN', 'LINUX', 'RHEL', 'SUSE', 'WINDOWS', 'WINDOWS_WITH_SQL_STANDARD', 'WINDOWS_WITH_SQL_WEB', 'WINDOWS_WITH_SQL_SERVER_ENTERPRISE', 'LINUX_WITH_SQL_STANDARD', 'LINUX_WITH_SQL_WEB', 'LINUX_WITH_SQL_SERVER_ENTERPRISE']

type

- **type:** string
- **description:** Reserved instance type
- **enum:** ['STANDARD', 'CONVERTIBLE']

location

- **description:** Location, either a zone or a data center if zone is not available
- **BaseApiDTO**

accountId

- **type:** string
- **description:** Account ID

accountDisplayName

- **type:** string
- **description:** Account display name

targetId

- **type:** string
- **description:** The associated target ID of the account

masterAccountId

- **type:** string
- **description:** Master account ID

term

- **description:** Term, unit is Year
- **StatApiDTO**

payment

- **type:** string
- **description:** Payment option
- **enum:** ['ALL_UPFRONT', 'PARTIAL_UPFRONT', 'NO_UPFRONT']

onDemandPrice

- **description:** On-demand price, saving is RI price minus on-demand price
- **StatApiDTO**

costPrice

- **description:** Total monthly cost
- **StatApiDTO**

coupons

- **description:** Total coupons and used coupons, utilization = numOfCouponsUsed / numOfCoupons
- **StatApiDTO**

totalCoupons

- **type:** number
- **format:** float
- **description:** Total coupons provided by the cbtp the vm matched with

expDate

- **type:** string
- **description:** Expiration date

instanceCount

- **type:** integer
- **format:** int32
- **description:** Number of reserved instance with the same type, template, platform etc..

tenancy

- **type:** string
- **description:** Tenancy
- **enum:** ['DEFAULT', 'DEDICATED', 'HOST']

upFrontCost

- **type:** number
- **format:** double
- **description:** Up front cost

actualHourlyCost

- **type:** number
- **format:** double
- **description:** Actual hourly cost

effectiveHourlyCost

- **type:** number
- **format:** double
- **description:** Effective hourly cost

isExpired

- **type:** boolean
- **description:** Whether the RI be expired by a date provided

expDateEpochTime

- **type:** integer
- **format:** int64
- **description:** Expiration Date in epoch time

scopeType

- **type:** string
- **description:** Whether the RI scope is Single or Shared (Azure)
- **enum:** ['SINGLE', 'SHARED', 'UNKNOWN']

appliedScopes

- **type:** array
- **description:** List of applied scope UUIDs- only provided when scope is Single (Azure)
- – **type:** string

orderID

- **type:** string
- **description:** The Order ID of the RI (Azure)

trueID

- **type:** string
- **description:** The ID of the RI

coveredEntityCount

- **type:** integer
- **format:** int32
- **description:** Count of workload entities covered by the reserved instance

undiscoveredAccountsCoveredCount

- **type:** integer
- **format:** int32
- **description:** Count of undiscovered accounts covered by the reserved instance

toBuy

- **type:** boolean

sizeFlexible

- **type:** boolean

ReservedInstancePurchaseSettingsDTO

Description**Optional Parameters****awsProfile**

- [PurchaseProfileDTO](#)

azureProfile

- [PurchaseProfileDTO](#)

ResizeActionDetailsApiDTO

Description

Parent class for resize action details. Implementing classes include: CloudResizeActionDetailsApiDTO.

Required Parameters

actionDetailType

- **type:** string

actionType

- **type:** string

Optional Parameters

subType

- **type:** string

ResourceApiDTO

Description

Model to describe the Resources of a Template

Optional Parameters

stats

- **type:** array
- **description:** Statistics, e.g. Number of CPU, Memory size, Disk size, ...
- – [StatApiDTO](#)

provider

- **description:** Entity provider
- [BaseApiDTO](#)

type

- **type:** string
- **description:** Type of the resource

template

- **type:** string
- **description:** Template used to fulfill the resources

relatedResources

- **type:** array
- **description:** ID of resources related to this resource
- – **type:** string

linkedResources

- **type:** array
- **description:** resources related to this resource. For now, this will only contain the cluster
- – [BaseApiDTO](#)

ResourceGroupApiDTO

Description

Inherits From

This DTO inherits from [GroupApiDTO](#)

Optional Parameters

parentUuid

- **type:** string
- **description:** Parent Business Account uuid (e.g subscription in Azure) where the Resource Group belongs to.

parentDisplayName

- **type:** string
- **description:** Parent Business Account display name (e.g subscription in Azure) where the Resource Group belongs to.

RoleApiDTO

Description

Model to describe a User Role, it describe the permissions of an user over the Ops. Manager capabilities

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

name

- **type:** string
- **description:** Name of the role

SAMLIdpApiDTO

Description

Model to describe an SAML IDP. It contains IDP URL and is SAML ONLY enabled or not.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

idpURL

- **type:** string
- **description:** The SAML IDP URL

isSAMLOnly

- **type:** boolean

isSingleLogoutEnabled

- **type:** boolean

STEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

displayName

- **type:** string
- **description:** Display Name

name

- **type:** string
- **description:** Name

productName

- **type:** string
- **description:** Product Name

productType

- **type:** string
- **description:** Product Type

deviceId

- **type:** string
- **description:** Device ID

deviceName

- **type:** string
- **description:** Device Name

externalNames

- **type:** array
- **description:** External Names
- – **type:** string

altName

- **type:** string
- **description:** Alternative Name

ssdDiskCount

- **type:** integer
- **format:** int64
- **description:** SSD Disk Count

rpm7200DiskCount

- **type:** integer
- **format:** int64
- **description:** RPM 7200 Disk Count

rpm10KDiskCount

- **type:** integer
- **format:** int64
- **description:** RPM 10K Disk Count

rpm15KDiskCount

- **type:** integer
- **format:** int64
- **description:** RPM 15K Disk Count

getvSeriesDiskCount

- **type:** integer
- **format:** int64
- **description:** VSeries Disk Count

ssdDiskIOPSCapacity

- **type:** number
- **format:** double
- **description:** SSD Disk IOPS Capacity

rpm7200DiskIOPSCapacity

- **type:** number
- **format:** double
- **description:** RPM 7200 Disk IOPS Capacity

rpm10KDiskIOPSCapacity

- **type:** number
- **format:** double
- **description:** RPM 10K Disk IOPS Capacity

rpm15KDiskIOPSCapacity

- **type:** number
- **format:** double
- **description:** RPM 15K Disk IOPS Capacity

getvSeriesDiskIOPSCapacity

- **type:** number

- **format:** double
- **description:** VSeries Disk IOPS Capacity

technologyType

- **type:** string
- **description:** HCI Technology Type

rawCapacity

- **type:** integer
- **format:** int64
- **description:** HCI Raw Capacity

rawFreespace

- **type:** integer
- **format:** int64
- **description:** HCI Raw Freespace

rawUncommitted

- **type:** integer
- **format:** int64
- **description:** HCI Raw Uncommitted

redundancyMethod

- **type:** string
- **description:** HCI Redundancy Method

failuresToTolerate

- **type:** integer
- **format:** int32
- **description:** HCI Failures To Tolerate

spaceReservationPct

- **type:** integer
- **format:** int32
- **description:** HCI Space Reservation Percentage

ScenarioApiDTO

Description

Model to describe a What-If Scenario, composed by a list of changes

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

owners

- **type:** array
- **description:** Users that owns the scenario
- – [UserApiDTO](#)

type

- **type:** string
- **description:** Type of the scenario

scope

- **type:** array
- **description:** List of entities/group that define the Scope
- – [BaseApiDTO](#)

projectionDays

- **type:** array
- **description:** List of days that define when the scenario should run
- – **type:** integer
- **format:** int32

topologyChanges

- **description:** Changes to apply to the topology of the plan market
- [TopologyChangesApiDTO](#)

loadChanges

- **description:** Workload utilization changes in the scenario
- [LoadChangesApiDTO](#)

configChanges

- **description:** Configuration changes in the scenario
- [ConfigChangesApiDTO](#)

changes

- **type:** array
- **description:** List of changes that describe the Scenario - [DEPRECATED - Use: loadChanges, configChanges]
- – [ScenarioChangeApiDTO](#)

timebasedTopologyChanges

- [TimeBasedTopologyChangesApiDTO](#)

ScenarioChangeApiDTO

Description

Model to describe a change in the Scenario, e.g. Add/Remove/Replace entities, change utilization, Add/Remove workload policies - [DEPRECATED]

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

index

- **type:** integer
- **format:** int32
- **description:** Index used to identify a change, used on remove

type

- **type:** string
- **description:** Type
- **enum:** ['ADDED', 'REMOVED', 'REPLACED', 'CONSTRAINTCHANGED', 'DISABLED', 'ENABLED', 'SET', 'ADD_HIST', 'INCLUDE_RESERVED', 'SET_HIST_BASELINE', 'SET_PEAK_BASELINE', 'SET_USED', 'SET_UTILIZATION', 'SET_ACTION_SETTING', 'SET_WORKLOAD_PLACEMENT', 'SET_MAX_UTILIZATION']

description

- **type:** string
- **description:** Description, e.g. Added n entities, Removed workload policy

mergeType

- **type:** string
- **description:** Merge type, used when type is SET_WORKLOAD_PLACEMENT
- **enum:** ['Cluster', 'StorageCluster', 'Datacenter', 'DesktopPool']

targets

- **type:** array
- **description:** List of Entities/Groups affected by the change
- – **BaseApiDTO**

value

- **type:** string
- **description:** if type ADDED: count to add, if SET_USED: percentage of util to increment/decrement, if SET_UTILIZATION: max percentage of utilization, if SET_HIST_BASELINE: time when to load the baseline, if SET_PEAK_BASELINE: time when to load the peak baseline, if CONSTRAINTCHANGED: true/false, if SET_WORKLOAD_PLACEMENT: ADDED, ENABLED, DISABLED, REMOVED

enable

- **type:** boolean
- **description:** used when type ADD_HIST, INCLUDE_RESERVED, ENABLE, DISABLED

capacity

- **type:** number

- **format:** float
- **description:** Indicate the max workload entities at the same time per placement entites, used when type is SET_WORKLOAD_PLACEMENT and policyType AT_MOST_N_BOUND

center

- **type:** number
- **format:** float
- **description:** Percentage of the Desired state Center, used when type is SET

diameter

- **type:** number
- **format:** float
- **description:** Percentage of the Desired state Diameter, used when type is SET

name

- **type:** string
- **description:** if type SET_WORKLOAD_PLACEMENT: policy name, if CONSTRAINTCHANGED: commodity name (All, DataCenterCommodity, ClusterCommodity, NetworkCommodity, DatastoreCommodity, StorageClusterCommodity, GlobalIgnoreConstraint)

maxUtilType

- **type:** string
- **description:** Type of the commodity, used when type is SET_MAX_UTILIZATION

policyType

- **type:** string
- **description:** Type of the policy
- **enum:** ['AT_MOST_N', 'BIND_TO_GROUP', 'BIND_TO_COMPLEMENTARY_GROUP', 'MUST_RUN_TOGETHER', 'AT_MOST_N_BOUND', 'MERGE', 'BIND_TO_GROUP_AND_LICENSE']

scope

- **type:** array
- **description:** List of entities/groups to describe the Scope of the Scenario
- – [BaseApiDTO](#)

projectionDays

- **type:** array
- **description:** List of projection days periods, indicate when to run the Plan Markets
- – **type:** integer
- **format:** int32

ScheduleApiDTO

Description

Model to describe the Schedule for a Settings Policy

Required Parameters

endTime

- **type:** string
- **format:** date-time

- **example:** 2019-04-04T19:15
- **description:** End time in hours and minutes for the scheduled period in ISO8601. For example, 2019-04-04T19:15

startDate

- **type:** string
- **format:** date-time
- **example:** 2019-04-04T19:15
- **description:** Start date of the schedule period, expressed using ISO8601 Format (YYYY-MM-DDTHH:MM:SS). This date is local to the timezone of the instance.

startTime

- **type:** string
- **format:** date-time
- **example:** 2019-04-04T19:15
- **description:** Start time in hours and minutes for the scheduled period in ISO8601. For example, 2019-04-04T17:15

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

endDate

- **type:** string
- **format:** date
- **example:** 2019-04-04
- **description:** End date of the schedule period, expressed using ISO8601 Format (YYYY-MM-DDTHH:MM:SS). This date is local to the timezone of the instance.

recurrence

- **description:** Recurrence setup
- **[RecurrenceApiDTO](#)**

timeZone

- **type:** string
- **description:** The time zone name based on tz database

nextOccurrence

- **type:** string
- **description:** The date and time of the next occurrence of this schedule represented in ISO8601 local time (YYYY-MM-DDTHH:MM:SS). For example, 2019-04-04T19:15

nextOccurrenceTimestamp

- **type:** integer
- **format:** int64
- **description:** The date and time of the next occurrence of this schedule represented in Timestamp in milliseconds. For example, 1562100619000

remaingTimeActiveInMs

- **type:** integer
- **format:** int64
- **description:** The amount of time that the schedule is going to be active at the time of call in milliseconds. This field will not be populated if the schedule is not currently active.

ScopeUuidsApiInputDTO

Description

Model to describe the request by UUIDs

Required Parameters

uuids

- **type:** array
- **description:** List of uuids
- – **type:** string
- **maxItems:** 2147483647
- **minItems:** 1

Optional Parameters

marketId

- **type:** string
- **description:** Market ID associated with the requested items

SearchAllQueryApiDTO

Description

A query used to search across the entire topology (entities and groups)

Required Parameters

select

- **description:** Defines what subset of types (entities and groups) should be returned.
- **readOnly:** True
- **SelectAllApiDTO**

where

- **description:** Conditions that each retrieved object must satisfy (currently only name is supported).
- **readOnly:** True
- **WhereApiDTO**

Optional Parameters

pagination

- **description:** Pagination information.
- **readOnly:** True
- **[PaginationApiDTO](#)**

SearchCountRecordApiDTO

Description

A count of entities.

Required Parameters

count

- **type:** integer
- **format:** int32
- **description:** Count of entities.
- **readOnly:** True

groupBys

- **type:** array
- **description:** List of fields describing the groupBys that this count represents
- **readOnly:** True
- – **[FieldValueApiDTO](#)**

SearchQueryRecordApiDTO

Description

A record with information about an entity or a group.

Required Parameters

oid

- **type:** integer
- **format:** int64
- **description:** Unique identifier for the entity or group.
- **readOnly:** True

values

- **type:** array
- **description:** Information about the entity or group.
- **readOnly:** True
- – **[FieldValueApiDTO](#)**

SelectAllApiDTO

Description

Specification of what subset of types (entities and groups) should be returned.

Optional Parameters

entityTypes

- **type:** array
- **description:** Entity types to include in the response.
- **readOnly:** True
- – **type:** string
 - **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

groupTypes

- **type:** array
- **description:** Group types to include in the response.
- **readOnly:** True
- – **type:** string
 - **enum:** ['Group', 'Resource', 'Cluster', 'VMCluster', 'StorageCluster', 'BillingFamily', 'NodePool']

SelectEntityApiDTO

Description

Specification of what fields should be fetched in an entity search response.

Required Parameters

entityType

- **type:** string
- **description:** Entity Type
- **readOnly:** True
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume',

'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMSpec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

Optional Parameters

fields

- **type:** array
- **description:** Fields to fetch.
- **readOnly:** True
- – [FieldApiDTO](#)

SelectGroupApiDTO

Description

Specification of what fields should be fetched in a group search response.

Required Parameters

groupType

- **type:** string
- **description:** Group Type.
- **readOnly:** True
- **enum:** ['Group', 'Resource', 'Cluster', 'VMCluster', 'StorageCluster', 'BillingFamily', 'NodePool']

Optional Parameters

fields

- **type:** array
- **description:** Fields to fetch.
- **readOnly:** True
- – [FieldApiDTO](#)

ServiceEntityApiDTO

Description

Model to describe an Entity, e.g. Virtual Machine, Physical Machine, Storage

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

priceIndex

- **type:** number
- **format:** float
- **description:** Price index of the Entity

state

- **type:** string
- **description:** State
- **enum:** ['IDLE', 'RESOURCE_ALLOCATION', 'LAUNCH', 'ACTIVE', 'RESOURCE_RELEASE', 'SUSPEND', 'SUSPEND_PENDING', 'TERMINATE_PENDING', 'NOT_MONITORED', 'MAINTENANCE', 'FAILOVER', 'UNKNOWN', 'EVACUATED', 'QUEUED']

severity

- **type:** string
- **description:** Highest severity of the Actions related to this entity
- **enum:** ['UNKNOWN', 'NORMAL', 'MINOR', 'MAJOR', 'CRITICAL']

unplacementDetails

- **description:** Additional information provided for unplaced entities in a plan
- **UnplacementDetailsApiDTO**

placedOn

- **type:** string
- **description:** The comma-separated classNames of entities successfully placed on, used for Unplaced entities in a Plan Market - [DEPRECATED - Use: unplacementDetails.placedOn]

notPlacedOn

- **type:** string
- **description:** The comma-separated classNames of entities could not be placed on, used for Unplaced entities in a Plan Market - [DEPRECATED - Use: unplacementDetails.reasons]

unplacedExplanation

- **type:** string
- **description:** The reason(s) the entity could not be placed - [DEPRECATED - Use: unplacementDetails.reasons]

costPrice

- **type:** number
- **format:** float
- **description:** Cost price per Hour

discoveredBy

- **description:** Target that discovered the entity
- **TargetApiDTO**

severityBreakdown

- **type:** object
- **description:** A Map of severity along with their count. E.g. {CRITICAL: 1, NORMAL: 10}
- **additionalProperties:** {'type': 'integer', 'format': 'int64'}

remoteId

- **type:** string

- **description:** The identifier of this instance on the remote target from which it was discovered - [DEPRECATED - Use: vendorIds]

realtimeMarketReference

- **description:** In case of a Plan Market Entity, this contains the original entity from the Real Time Market
- **BaseApiDTO**

providers

- **type:** array
- **description:** List of Providers
- – **BaseApiDTO**

consumers

- **type:** array
- **description:** List of Consumers
- – **BaseApiDTO**

template

- **description:** Related Template
- **TemplateApiDTO**

numRelatedVMs

- **type:** integer
- **format:** int32
- **description:** Number of related VMs

connectedEntities

- **type:** array
- **description:** Limited list of connected entities relevant to the service entity. This will not contain all connected entities.
- – **BaseApiDTO**

aspects

- **type:** object
- **description:** Additional info about the Entity categorized as Aspects
- **additionalProperties:** {'\$ref': '#/definitions/EntityAspect'}

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM']

tags

- **type:** object
- **description:** Tags are the metadata defined in name/value pairs. Each name can have multiple values.
- **additionalProperties:** {'type': 'array', 'items': {'type': 'string'}}

onDemandRateBefore

- **type:** number
- **format:** float

- **description:** On-demand rate before actions

onDemandRateAfter

- **type:** number
- **format:** float
- **description:** On-demand rate after actions

vendorIds

- **type:** object
- **description:** The mapping of target identifier to vendor-provided identity of this entity on the remote target
- **additionalProperties:** {'type': 'string'}

ServletOutputStream

Description

Optional Parameters

ready

- **type:** boolean

SettingActivePolicyApiDTO

Description

Model to describe a Settings Policy that affect the value of a Setting

Required Parameters

numEntities

- **type:** integer
- **format:** int32
- **description:** Number of entities affected by the Settings Policy value

settingsPolicy

- **description:** Settings Policy that affects the final value of a Setting
- **BaseApiDTO**

value

- **type:** string
- **description:** Setting value declared in the Settings Policy

SettingApiDTOSerializable

Description

Generic model to describe a Setting. Sub types include StringSettingApiDTO and RIPurchaseProfilesSettingApiDTO.

Required Parameters

value

- **description:** Value of the setting. Type indicated by the `valueObjectType` field. The default type is `String`
- **\$ref:** [#/definitions/object](#)

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

valueDisplayName

- **type:** string
- **description:** Display Name of the Value, in case the value is a Template or another entity
- **readOnly:** True

defaultValue

- **description:** Default value before any change
- **readOnly:** True
- **\$ref:** [#/definitions/object](#)

categories

- **type:** array
- **description:** Category and sub categories of the setting
- **readOnly:** True
- – **type:** string

valueType

- **type:** string
- **description:** Define the type of the value
- **enum:** ['STRING', 'NUMERIC', 'BOOLEAN']

valueObjectType

- **type:** string
- **description:** The type of complex object values. Defaults to 'String'.
- **enum:** ['String', 'ReservedInstancePurchaseSettingsDTO']

options

- **type:** array
- **description:** List of allowable value for this setting
- **readOnly:** True
- – [SettingOptionApiDTO](#)

min

- **type:** number
- **format:** double
- **description:** If type is NUMERIC, this define the min limit
- **readOnly:** True

max

- **type:** number
- **format:** double
- **description:** If type is NUMERIC, this define the max limit
- **readOnly:** True

entityType

- **type:** string
- **description:** Entity type for this Setting

range

- **description:** Range options for the value of the setting
- **readOnly:** True
- **RangeApiDTO**

scope

- **type:** string
- **description:** Define the visibility of the setting. E.G. a Local Setting is only visible when associated with an Entity/Group
- **readOnly:** True
- **enum:** ['GLOBAL', 'LOCAL']

activeSettingsPolicies

- **type:** array
- **description:** List of Settings Policies that are affecting the final value of this setting
- – **SettingActivePolicyApiDTO**

sourceGroupName

- **type:** string
- **description:** Source group name for setting value

sourceGroupUuid

- **type:** string
- **description:** Source group uuid for setting value

SettingApiDTOString

Description

Generic model to describe a Setting. Sub types include StringSettingApiDTO and RIPurchaseProfilesSettingApiDTO.

Required Parameters

value

- **description:** Value of the setting. Type indicated by the `valueObjectType` field. The default type is `String`
- **\$ref:** [#/definitions/object](#)

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

valueDisplayName

- **type:** string
- **description:** Display Name of the Value, in case the value is a Template or another entity
- **readOnly:** True

defaultValue

- **description:** Default value before any change
- **readOnly:** True
- **\$ref:** [#/definitions/object](#)

categories

- **type:** array
- **description:** Category and sub categories of the setting
- **readOnly:** True
- – **type:** string

valueType

- **type:** string
- **description:** Define the type of the value
- **enum:** ['STRING', 'NUMERIC', 'BOOLEAN']

valueObjectType

- **type:** string
- **description:** The type of complex object values. Defaults to 'String'.
- **enum:** ['String', 'ReservedInstancePurchaseSettingsDTO']

options

- **type:** array
- **description:** List of allowable value for this setting
- **readOnly:** True
- – [SettingOptionApiDTO](#)

min

- **type:** number
- **format:** double
- **description:** If type is NUMERIC, this define the min limit
- **readOnly:** True

max

- **type:** number
- **format:** double
- **description:** If type is NUMERIC, this define the max limit
- **readOnly:** True

entityType

- **type:** string
- **description:** Entity type for this Setting

range

- **description:** Range options for the value of the setting
- **readOnly:** True
- **RangeApiDTO**

scope

- **type:** string
- **description:** Define the visibility of the setting. E.G. a Local Setting is only visible when associated with an Entity/Group
- **readOnly:** True
- **enum:** ['GLOBAL', 'LOCAL']

activeSettingsPolicies

- **type:** array
- **description:** List of Settings Policies that are affecting the final value of this setting
- – **SettingActivePolicyApiDTO**

sourceGroupName

- **type:** string
- **description:** Source group name for setting value

sourceGroupUuid

- **type:** string
- **description:** Source group uuid for setting value

SettingApiDTO

Description

Generic model to describe a Setting. Sub types include StringSettingApiDTO and RIPurchaseProfilesSettingApiDTO.

Required Parameters

value

- **description:** Value of the setting. Type indicated by the `valueObjectType` field. The default type is `String`
- **\$ref:** [#/definitions/object](#)

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

valueDisplayName

- **type:** string
- **description:** Display Name of the Value, in case the value is a Template or another entity
- **readOnly:** True

defaultValue

- **description:** Default value before any change
- **readOnly:** True
- **\$ref:** [#/definitions/object](#)

categories

- **type:** array
- **description:** Category and sub categories of the setting
- **readOnly:** True
- – **type:** string

valueType

- **type:** string
- **description:** Define the type of the value
- **enum:** ['STRING', 'NUMERIC', 'BOOLEAN']

valueObjectType

- **type:** string
- **description:** The type of complex object values. Defaults to 'String'.
- **enum:** ['String', 'ReservedInstancePurchaseSettingsDTO']

options

- **type:** array
- **description:** List of allowable value for this setting
- **readOnly:** True
- – [SettingOptionApiDTO](#)

min

- **type:** number
- **format:** double
- **description:** If type is NUMERIC, this define the min limit
- **readOnly:** True

max

- **type:** number
- **format:** double
- **description:** If type is NUMERIC, this define the max limit
- **readOnly:** True

entityType

- **type:** string
- **description:** Entity type for this Setting

range

- **description:** Range options for the value of the setting
- **readOnly:** True
- **RangeApiDTO**

scope

- **type:** string
- **description:** Define the visibility of the setting. E.G. a Local Setting is only visible when associated with an Entity/Group
- **readOnly:** True
- **enum:** ['GLOBAL', 'LOCAL']

activeSettingsPolicies

- **type:** array
- **description:** List of Settings Policies that are affecting the final value of this setting
- – **SettingActivePolicyApiDTO**

sourceGroupName

- **type:** string
- **description:** Source group name for setting value

sourceGroupUuid

- **type:** string
- **description:** Source group uuid for setting value

SettingOptionApiDTO

Description

Optional Parameters

label

- **type:** string

value

- **type:** string

SettingsManagerApiDTO

Description

Model to describe a Category Manager for the settings

Required Parameters

category

- **type:** string
- **description:** Category of the Manager

settings

- **type:** array
- **description:** List of Settings contained in the Manager
- – [SettingApiDTOSerializable](#)

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

SettingsPolicyApiDTO

Description

Model to describe a Setting Policy: a group of Settings that are applied based on Scope and/or Schedule

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

entityType

- **type:** string

- **description:** Type of the Settings Policy. E.G. VirtualMachine, PhysicalMachine, ...

scopes

- **type:** array
- **description:** List of scopes where the settings are applied, on create/edit, only Uuid is required. If null it's considered Global scope
- – [GroupApiDTO](#)

settingsManagers

- **type:** array
- **description:** List of groups of Settings to activate in this Policy
- – [SettingsManagerApiDTO](#)

schedule

- **description:** Schedule to define when the settings are applied
- [ScheduleApiDTO](#)

disabled

- **type:** boolean
- **description:** Control if the policy is Enabled or Disabled

note

- **type:** string
- **description:** Note for this Policy

readOnly

- **type:** boolean
- **description:** If true, prevents users from deleting or modifying the SettingPolicy.

default

- **type:** boolean

SkippedActionApiDTO

Description

Model to describe an action that was skipped in execution.

Required Parameters

actionId

- **type:** string
- **description:** Action ID

Optional Parameters

reason

- **type:** string
- **description:** Reason why action was skipped

StatApiDTO

Description

Model to describe a Statistic

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

name

- **type:** string
- **description:** Name

capacity

- **description:** Capacity values, used for Commodities stats
- [StatValueApiDTO](#)

reserved

- **description:** Reserved values, used for Commodities stats
- [StatValueApiDTO](#)

relatedEntityType

- **type:** string
- **description:** E.G.virtual machine

filters

- **type:** array
- **description:** describe the grouping options used to generate the output
- – [StatFilterApiDTO](#)

relatedEntity

- **description:** Provider or Consumer of the Statistic, 'relatedEntity' and 'numRelatedEntities' are mutually exclusive
- [BaseApiDTO](#)

numRelatedEntities

- **type:** integer
- **format:** int32
- **description:** Number of providers or consumers for this statistic, 'relatedEntity' and 'numRelatedEntities' are mutually exclusive

units

- **type:** string

- **description:** Units, used for Commodities stats. E.G. \$/h

values

- **description:** Contains Average, Min, Max, Total
- **StatValueApiDTO**

value

- **type:** number
- **format:** float
- **description:** Simple value, equal to values.avg.

histUtilizations

- **type:** array
- **description:** Commodity historical utilization values
- – **StatHistUtilizationApiDTO**

StatApiInputDTO

Description

Model to describe the request of a Stat

Optional Parameters

name

- **type:** string
- **description:** Name of the stat

relatedEntityType

- **type:** string
- **description:** Used to get stats from different entity types in the supply chain of {uuid} E.G.costPrice of the VMs where the scope is a PM

filters

- **type:** array
- **description:** Filters to apply to the requested stats. Commodities supported values: key = {commodity_key}, relation = sold|bought, virtualDisk = {uuid}. Cost Price supported values: cumulative = true|false, cloudService = {uuid}, target = {uuid}, CSP = {name}, category = {name}, businessUnit = {uuid}, costComponent = COMPUTE|IP|LICENSE|STORAGE, costComponentArtifact = {key}. Action stats supported values: actionTypes = {actionType}, actionModes: {action_mode}, actionStates: {action_state}, riskSubCategory: Performance Assurance|Efficiency Improvement|Prevention|Compliance, riskSeverity: UNKNOWN|NORMAL|MINOR|MAJOR|CRITICAL
- – **StatFilterApiDTO**

groupBy

- **type:** array
- **description:** Execute a groupBy on the values of the stats. Commodities supported values: key, relatedEntity, virtualDisk. Cost Price supported values: cloudService, target, CSP, category, businessUnit, costComponent, costComponentArtifact. Action stats supported values: actionTypes, actionModes, actionStates, risk, riskSubCategory, riskSeverity
- – **type:** string

historyType

- **type:** string
- **description:** Query the histUtilization table for these historyTypes
- **enum:** ['Percentile', 'Smoothed']

StatFilterApiDTO

Description

Model to describe the filter applied to a Statistic

Required Parameters

type

- **type:** string
- **description:** type of the filter, E.G: actionTypes, category, ...

Optional Parameters

value

- **type:** string
- **description:** value of the filter

StatHistUtilizationApiDTO

Description

Model to describe a historical utilization statistic, e.g. the P95 vCPU or P95 vMEM of a VM over (up to) NN days observation period.

Optional Parameters

type

- **type:** string
- **description:** Historical utilization type

usage

- **type:** number
- **format:** float
- **description:** Historical usage

capacity

- **type:** number
- **format:** float
- **description:** Historical capacity

resizeMaxScalingObservationPeriod

- **type:** number
- **format:** float
- **description:** Resize max scaling observation period. Affects on amount of data points considered for action generation process. Value in days.

resizeScalingAggressiveness

- **type:** number
- **format:** float
- **description:** Resize scaling aggressiveness. Describes how aggressively Turbonomic will resize in response of resource utilization. Value in percents. 100% least aggressive, 95% most aggressive.

StatPeriodApiInputDTO

Description

Model to describe the request for Statistics by a Time range

Required Parameters

statistics

- **type:** array
- **description:** List of requested statistics, if empty all stats will be processed
- – [StatApiInputDTO](#)

Optional Parameters

startDate

- **type:** string
- **description:** Start time of the period to filter, if empty the current stats will be processed

endDate

- **type:** string
- **description:** End time of the period to filter, if empty the current stats will be processed

StatScopesApiInputDTO

Description

Model to describe the request for Statistics in multiple Scopes

Optional Parameters

scopes

- **type:** array
- **description:** List of uuid to use as scope
- – **type:** string

period

- **description:** List of requested statistics
- [StatPeriodApiInputDTO](#)

relatedType

- **type:** string
- **description:** Get the stats for the entity type related to the scopes

StatSnapshotApiDTO

Description

Model to describe the Statistics of a snapshot, contains a list of Statistics for a moment in time

Required Parameters

statistics

- **type:** array
- **description:** List of statistics, e.g. Price Index, Commodities values, Cost price, Number of VMs in a Group, ...
- – [StatApiDTO](#)

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

date

- **type:** string
- **description:** When the statistics were recorded

epoch

- **type:** string
- **description:** An indicator of whether the snapshot represents historical, projected or plan data. Should be used in conjunction with the date field to understand the context of this stat snapshot.
- **enum:** ['HISTORICAL', 'CURRENT', 'PROJECTED', 'PLAN_SOURCE', 'PLAN_PROJECTED']

StatValueApiDTO

Description

Model to describe a single statistic, e.g. the CPU of a PM Group

Optional Parameters

max

- **type:** number
- **format:** float
- **description:** Max value

min

- **type:** number
- **format:** float

- **description:** Min value

avg

- **type:** number
- **format:** float
- **description:** Average value

total

- **type:** number
- **format:** float
- **description:** Total value - sum of average values in a group

totalMax

- **type:** number
- **format:** float
- **description:** Total max value - sum of max values in a group

totalMin

- **type:** number
- **format:** float
- **description:** Total min value - sum of min values in a group

StringSettingApiDTO

Description

Inherits From

This DTO inherits from [SettingApiDTO](#)

Required Parameters

value

- **type:** string
- **description:** Value of the setting. Type indicated by the `valueObjectType` field. The default type is `String`

Optional Parameters

defaultValue

- **type:** string
- **description:** Default value before any change
- **readOnly:** True

SupplyChainStatsApiInputDTO

Description

Model to describe a Filter for Entities

Required Parameters

uuids

- **type:** array
- **description:** List of uuids used to build the supply chain
- – **type:** string
- **maxItems:** 2147483647
- **minItems:** 1

Optional Parameters

types

- **type:** array
- **description:** List of Types to filter
- – **type:** string

states

- **type:** array
- **description:** List of States to filter
- – **type:** string
 - **enum:** ['IDLE', 'RESOURCE_ALLOCATION', 'LAUNCH', 'ACTIVE', 'RESOURCE_RELEASE', 'SUSPEND', 'SUSPEND_PENDING', 'TERMINATE_PENDING', 'NOT_MONITORED', 'MAINTENANCE', 'FAILOVER', 'UNKNOWN', 'EVACUATED', 'QUEUED']

groupBy

- **type:** array
- **description:** List of fields used to group the Stats
- – **type:** string
 - **enum:** ['entityType', 'state', 'severity', 'riskSubCategory', 'template', 'target', 'businessUnit', 'resourceGroup', 'nodePool']

environmentType

- **type:** string
- **description:** Filter the actions by Environment Type
- **enum:** ['ONPREM', 'CLOUD']

SupplychainApiDTO

Description

Model to describe the Supply Chain: the Environment is described as a chain between Producers and Consumers

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string

- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

seMap

- **type:** object
- **description:** Model to describe the type of Entity associated with a SupplyChainEntry
- **additionalProperties:** {'\$ref': '#/definitions/SupplychainEntryDTO'}

SupplychainEntryDTO

Description

Model to describe a Supply Chain Entry

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

depth

- **type:** integer
- **format:** int32
- **description:** Number to indicate the level of depth of the Entity type in the Supply Chain

entitiesCount

- **type:** integer
- **format:** int32
- **description:** Number of entity in this level of depth

healthSummary

- **type:** object
- **description:** Entities count by Severity
- **additionalProperties:** {'type': 'integer', 'format': 'int32'}

stateSummary

- **type:** object
- **description:** Entities count by State
- **additionalProperties:** {'type': 'integer', 'format': 'int32'}

connectedProviderTypes

- **type:** array
- **description:** List of provider types connected to this level of depth

- **uniqueItems:** True
- – **type:** string

connectedConsumerTypes

- **type:** array
- **description:** List of consumer types connected to this level of depth
- **uniqueItems:** True
- – **type:** string

instances

- **type:** object
- **description:** List of entities in this level of depth
- **additionalProperties:** {'\$ref': '#/definitions/ServiceEntityApiDTO'}

TagApiDTO

Description

Tag information

Optional Parameters

key

- **type:** string
- **description:** Tag key

values

- **type:** array
- **description:** Tag value
- – **type:** string

TargetApiDTO

Description

Model to describe a Target. Targets are used to discover the components to create a connected virtual environment

Required Parameters

type

- **type:** string
- **description:** Probe type. Turbonomic ships with the following probe types: AppDynamics, Dynatrace, Datadog, Arista, AWS, Azure, Cisco APIC, Cisco HyperFlex, Cisco UCS Central, Cisco UCS Director, Cisco UCS Manager, CloudFoundry, CloudStack, Dell Compellent, EMC ScaleIO, EMC VMAX, EMC VNX, EMC VPLEX, EMC XtremIO, Hitachi Vantara, HP OneView, HPE 3PAR, Hyper-V, IBM PowerVM, Instana, JBoss, JVM, MExchange, MySQL, NetApp, NetFlow, NetScaler, Nutanix, OpenStack, Oracle, Pivotal Ops Manager, Pure, Red Hat Virtualization Manager, sFlow, SNMP, SoftLayer, SQLServer, Tetration, Tomcat, vCenter, vCloudDirector, VMM, WebLogic, WebSphere, WMI, XenServer,

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

category

- **type:** string
- **example:** Hypervisor
- **description:** Probe category.

uiCategory

- **type:** string
- **example:** Application Server, Billing, Cloud Management, Applications and Databases, Fabric and Network, Guest OS Processes, HYPERCONVERGED, HYPERVISOR, Load Balancer, Operations Manager Appliance, ORCHESTRATOR, PaaS, Storage, Storage Browsing, WINDOWS APPLICATION. There are also categories Custom and UNKNOWN to be used for new probe development.
- **description:** Probe UI category.

identifyingFields

- **type:** array
- **description:** Array of field names used to differentiate probes of the same category. Most typically either the name/address field, or a combination of address and port.
- – **type:** string

inputFields

- **type:** array
- **description:** List of all InputFieldApiDTO objects for the target, analogous to the target addition form fields in the GUI.
- – **InputFieldApiDTO**

lastValidated

- **type:** string
- **description:** Date of the last validation - [DEPRECATED - Use: healthSummary.timeOfLastSuccessfulDiscovery]

status

- **type:** string
- **example:** Validated, VALIDATION FAILED, UNKNOWN
- **description:** Description of the status of the most recent Validation Operation - [DEPRECATED - Use: healthSummary.healthState]

derivedTargets

- **type:** array
- **description:** Targets derived (created by discovery of) from this target. Populated depending on the TargetRelationship parameter.

- – [TargetApiDTO](#)

patchedTargets

- **type:** array
- **description:** Targets patched by this target
- – [PatchedTargetDataApiDTO](#)

parentTargets

- **type:** array
- **description:** Targets that created this target. Populated depending on the TargetRelationship parameter.
- – [TargetApiDTO](#)

readonly

- **type:** boolean
- **description:** Whether the target cannot be changed through public APIs.

healthSummary

- **description:** The health summary of the target.
- [TargetHealthSummaryApiDTO](#)

TargetErrorDetailsApiDTO

Description

Additional details related to a target error.

Required Parameters

targetErrorDetailsClass

- **type:** string

TargetHealthApiDTO

Description

A DTO that describes the health of a single target.

Required Parameters

healthCategory

- **type:** string
- **description:** The type of the health checks that are done.
- **enum:** ['TARGET', 'ACTION']

healthClassDiscriminator

- **type:** string
- **example:** TargetHealthApiDTO
- **description:** Health type discriminator. Describes which subclass of BaseHealthApiDTO is returned.

targetName

- **type:** string

- **description:** Target display name.

uuid

- **type:** string
- **description:** UUID of the target.

Optional Parameters

errorText

- **type:** string
- **description:** Error text (if there's any).

timeOfFirstFailure

- **type:** string
- **description:** Time of first failure of validation/discovery (if the target is in failed state; ISO-8601 formatted String).

targetErrorDetails

- **type:** array
- **description:** Error details related to a target. Supports multiple errors details.
- – **TargetErrorDetailsApiDTO**

targetStatusSubcategory

- **type:** string
- **enum:** ['DISCOVERY', 'VALIDATION', 'DUPLICATION', 'DELAYED_DATA']

healthState

- **type:** string
- **enum:** ['CRITICAL', 'MAJOR', 'MINOR', 'NORMAL']

TargetHealthSummaryApiDTO

Description

A DTO that describes target health.

Required Parameters

healthState

- **type:** string
- **example:** NORMAL
- **description:** The target health state.
- **enum:** ['CRITICAL', 'MAJOR', 'MINOR', 'NORMAL']

Optional Parameters

timeOfLastSuccessfulDiscovery

- **type:** string
- **example:** 2021-07-07T20:33:49Z
- **description:** The last time a successful discovery finished on the target in ISO-8601 Format (YYYY-MM-DDTHH:MM:SSZ). For example 2021-07-07T20:33:49Z

TargetOperationStageApiDTO

Description

Holds all information related to a stage of discovery or validation.

Optional Parameters

description

- **type:** string
- **description:** The description of what this stage is doing (ideally in less than 70 characters). Example of description are "validating credentials" or "retrieving business applications".

status

- **description:** Holds all the information of this particular instance of the discovery or validation stage.
- [TargetOperationStageStatusApiDTO](#)

TargetOperationStageStatusApiDTO

Description

Holds all the information of this particular instance of the discovery or validation stage.

Optional Parameters

state

- **type:** string
- **description:** The state of this stage at the end of the discovery or validation.
- **enum:** ['DID_NOT_RUN', 'SUCCESS', 'FAILURE']

summary

- **type:** string
- **description:** The short message (ideally 70 characters or less) explaining the stage status. Example of such messages are "invalid credentials" or "4 business application retrieved".

fullExplanation

- **type:** string
- **description:** The full message explaining the stage status. This explanation may include the instructions or hints on how to address issue if there is one.

TargetThirdPartyErrorDetailsApiDTO

Description

Inherits From

This DTO inherits from [TargetErrorDetailsApiDTO](#)

Optional Parameters

targetErrorType

- **type:** string

- **description:** Target validation/discovery error type.
- **enum:** ['INTERNAL_PROBE_ERROR', 'CONNECTIVITY_ERROR', 'UNAUTHENTICATED', 'TOKEN_UNAVAILABLE', 'VERSION_NOT_SUPPORTED', 'DATA_ACCESS_ERROR', 'DUPLICATION', 'DELAYED_DATA', 'THIRD_PARTY_FAILURE']

errorCode

- **type:** string
- **example:** 0x423232, 404, 400
- **description:** Error code related to the failure.

endPoint

- **type:** string
- **description:** End point which caused the third party api failure. This can be a complete URL or a method name while using the third party SDK.

TelemetryDTO

Description

Model to describe the status of telemetry

Optional Parameters

telemetryTermsViewed

- **type:** boolean
- **description:** Controls when an administrator should be shown the telemetry opt in

telemetryEnabled

- **type:** boolean
- **description:** Controls whether analytics and telemetry are enabled

TemplateApiDTO

Description

Model to describe a Template: contains the resources used to Deploy a VM or to Add Workload/Supply in a Plan

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

price

- **type:** number

- **format:** float
- **description:** The estimated cost of the template. Used for Physical Machine and Storage templates where the hardware cost is known.

model

- **type:** string
- **example:** Cisco UCS B200 M5 (Intel Xeon Gold 5115, 2.40 GHz), PowerEdge R940 (Intel Xeon Gold 6136, 3.00 GHz), etc.
- **description:** The model of the entire Physical Machine system.

cpuModel

- **type:** string
- **example:** Intel Xeon Gold 6130, AMD Opteron 6166 HE, etc.
- **description:** The model of the CPU in the Physical Machine.

vendor

- **type:** string
- **example:** Cisco, Microsoft, HP, Novell
- **description:** Vendor of the templated entity

description

- **type:** string
- **description:** Description

image

- **type:** string
- **description:** Container Profile image

imageTag

- **type:** string
- **description:** (UNUSED) Container Profile image tag

cmdWithArgs

- **type:** string
- **description:** (UNUSED) Container command with Arguments

dbEngine

- **type:** string
- **example:** PostgreSQL, AuroraMySQL, SqlServer
- **description:** Database engine, used for Database templates

dbEdition

- **type:** string
- **example:** Standard One, Enterprise, Premium_P2
- **description:** Database edition, used for Database templates

computeResources

- **type:** array
- **description:** ResourceApiDTO describing the compute resources. Max 1 per template.
- – [ResourceApiDTO](#)
- **maxItems:** 1

- **minItems:** 0

storageResources

- **type:** array
- **description:** ResourceApiDTO describing the storage resources
- – [ResourceApiDTO](#)

networkResources

- **type:** array
- **description:** ResourceApiDTO describing the network resources
- – [ResourceApiDTO](#)

infrastructureResources

- **type:** array
- **description:** ResourceApiDTO describing the infrastructure resources. Max 1 per template
- – [ResourceApiDTO](#)
- **maxItems:** 1
- **minItems:** 0

deploymentProfile

- **description:** Deployment profile associated with the template
- [DeploymentProfileApiDTO](#)

discovered

- **type:** boolean
- **example:** False
- **description:** Indicates if the template is discovered or manually created
- **enum:** [True, False]

family

- **type:** string
- **example:** standardDSv2Family, standardNCFamily, r5d, r3
- **description:** For cloud templates, the instance family.

enableMatch

- **type:** boolean
- **example:** False
- **description:** Add to Infrastructure Cost Policy. Infrastructure Cost policies group hardware devices according to their cost

TemplateApiInputDTO

Description

Model to describe a Template: contains the resources used to Deploy a VM or to Add Workload/Supply in a Plan

Optional Parameters

displayName

- **type:** string

- **description:** Name of the template

className

- **type:** string
- **description:** className
- **enum:** ['VirtualMachine', 'PhysicalMachine', 'Storage', 'Container']

price

- **type:** number
- **format:** float
- **description:** Cost price

model

- **type:** string
- **description:** The Model of the entire Physical Machine system. For example: Cisco UCS B200 M5 (Intel Xeon Gold 5115, 2.40 GHz) vs. PowerEdge R940 (Intel Xeon Gold 6136, 3.00 GHz)

cpuModel

- **type:** string
- **description:** The model of the CPU in the Physical Machine. This is separate from the model of the entire Physical Machine. For example: Intel Xeon Gold 6130 vs. AMD Opteron 6166 HE

vendor

- **type:** string
- **description:** Vendor

description

- **type:** string
- **description:** Description

image

- **type:** string
- **description:** Profile image, used for Container templates

imageTag

- **type:** string
- **description:** Profile image tag, used for Container templates

cmdWithArgs

- **type:** string
- **description:** Command with Arguments, used for Container templates

computeResources

- **type:** array
- **description:** Compute resources: Number of CPU, CPU speed, Memory size, ...
- – **ResourceApiDTO**
- **maxItems:** 1
- **minItems:** 0

storageResources

- **type:** array
- **description:** Storage resources: Disk I/O, Disk Size, Percentage of Disk consumed

- – [ResourceApiDTO](#)

networkResources

- **type:** array
- **description:** Network resources
- – [ResourceApiDTO](#)

infrastructureResources

- **type:** array
- **description:** Infrastructure resources: Power, Size, Cooling
- – [ResourceApiDTO](#)
- **maxItems:** 1
- **minItems:** 0

deploymentProfileId

- **type:** string
- **description:** Ids of the Deployment Profiles associated with this Template

enableMatch

- **type:** boolean
- **description:** Add to Infrastructure Cost Policy. Infrastructure Cost policies group hardware devices according to their cost

TemplatePriceAdjustmentDTO

Description

Price adjustment information for a template within a business unit and specified pricing model.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

discount

- **type:** number
- **format:** float
- **description:** Entity discount percentage

priceAdjustment

- **description:** Entity price adjustment percentage
- **PriceAdjustmentDTO**

family

- **type:** string
- **description:** Family of a template, group of similar purpose templates. Available only for virtual machine templates.

pricesPerDatacenter

- **type:** array
- **description:** Template base rates per data center, provided for information purpose.
- – **EntityPriceDTO**

TextConditionApiDTO

Description

Inherits From

This DTO inherits from [ConditionApiDTO](#)

Required Parameters

value

- **type:** string
- **description:** A regular expression to be matched against the value of the field.
- **readOnly:** True

TextFieldValueApiDTO

Description

Inherits From

This DTO inherits from [FieldValueApiDTO](#)

Required Parameters

value

- **type:** string
- **description:** The value.
- **readOnly:** True

TimeBasedTopologyChangesApiDTO

Description

Topology changes based on a timeframe in the scenario

Optional Parameters

includeReservation

- **type:** boolean
- **description:** Add the workload that is currently reserved

reservationCount

- **type:** integer
- **format:** int32
- **description:** # of currently reserved VMs
- **readOnly:** True

addHistoryVMs

- **type:** boolean
- **description:** Should historical vmNetGrowth be considered

vmNetGrowth

- **type:** integer
- **format:** int32
- **description:** Number of workloads added during the last month
- **readOnly:** True

TopologyChangesApiDTO

Description

Topology changes in the scenario

Optional Parameters

addList

- **type:** array
- **description:** List of add changes in the Topology
- – [AddObjectApiDTO](#)

removeList

- **type:** array
- **description:** List of remove changes in the Topology
- – [RemoveObjectApiDTO](#)

replaceList

- **type:** array
- **description:** List of replace changes in the Topology
- – [ReplaceObjectApiDTO](#)

migrateList

- **type:** array
- **description:** List of migrate changes in the Topology
- – [MigrateObjectApiDTO](#)

relievePressureList

- **type:** array
- **description:** List of relieve pressure changes in the Topology
- – [RelievePressureObjectApiDTO](#)

TopologyDataDefinitionApiDTO

Description

Model to describe a user-defined topology definition.

Required Parameters

entityDefinitionData

- **description:** Entity definition data
- [IEntityDefinitionData](#)

entityType

- **type:** string
- **description:** The type of service entity being defined
- **enum:** ['BusinessApplication', 'BusinessTransaction', 'Service']

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

contextBased

- **type:** boolean
- **description:** Defines if this Definition is Context-Based.

UnplacementDetailsApiDTO

Description

Additional information provided for entities in a plan that are unplaced

Required Parameters

reasons

- **type:** array
- **description:** Detailed information about why the entity could not be placed
- – [UnplacementReasonApiDTO](#)

Optional Parameters

placedOn

- **type:** array
- **description:** For Unplaced entities in a Plan Market, the providers that this entity was able to place on
- – [BaseApiDTO](#)

UnplacementReasonApiDTO

Description

Details to describe why an entity could not be placed

Optional Parameters

failedResources

- **type:** array
- **description:** A list of resources that caused the entity not to be placed
- – [FailedResourceApiDTO](#)

resourceOwner

- **description:** The entity owning the resources that caused unplacement, if different than this entity. For example, a volume that caused a VM to be unplaced.
- [BaseApiDTO](#)

providerType

- **type:** string
- **description:** The entity type that sells the commodities that caused unplacement.
- **enum:** ['Application', 'ApplicationComponent', 'ApplicationServer', 'AvailabilityZone', 'BusinessAccount', 'BusinessApplication', 'BusinessTransaction', 'BusinessUser', 'Chassis', 'CloudService', 'ComputeTier', 'Container', 'ContainerPod', 'ContainerSpec', 'Database', 'DatabaseServer', 'DatabaseServerTier', 'DatabaseTier', 'DataCenter', 'DesktopPool', 'DiskArray', 'DPod', 'HCIPhysicalMachine', 'HypervisorServer', 'Internet', 'IOModule', 'LoadBalancer', 'LogicalPool', 'Namespace', 'Network', 'PhysicalMachine', 'ProcessorPool', 'Region', 'ReservedInstance', 'Service', 'ServiceProvider', 'Storage', 'StorageController', 'StorageTier', 'Switch', 'Unknown', 'ViewPod', 'VirtualApplication', 'VirtualDataCenter', 'VirtualMachine', 'VirtualVolume', 'VPod', 'WorkloadController', 'ContainerPlatformCluster', 'VMspec', 'CloudCommitment', 'ApplicationComponentSpec', 'VirtualMachineSpec']

closestSeller

- **description:** The seller that came closest to satisfying the commodities. This information is not always available.
- [BaseApiDTO](#)

placementProblem

- **type:** string
- **description:** Categorizes the reason which caused unplacement
- **enum:** ['COSTS_NOT_FOUND', 'NOT_CONTROLLABLE', 'UNSATISFIED_COMMODITIES']

UserApiDTO

Description

Model to describe an User

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

username

- **type:** string
- **description:** Username

password

- **type:** string
- **description:** Encoded password

roleUuid

- **type:** string
- **description:** Role Id. In an API output this will be the uuid of the first role in the "roles" field. It will be ignored in an API input if the "roles" field is set. - [DEPRECATED - EOL: 8.6.1 - Use: roles]

roleName

- **type:** string
- **description:** Role name. In an API output this will be the name of the first role in the "roles" field. It will be ignored in an API input if the "roles" field is set. - [DEPRECATED - EOL: 8.6.1 - Use: roles]
- **enum:** ['ADMINISTRATOR', 'SITE_ADMIN', 'AUTOMATOR', 'DEPLOYER', 'ADVISOR', 'OBSERVER', 'OPERATIONAL_OBSERVER', 'SHARED_ADVISOR', 'SHARED_OBSERVER']

roles

- **type:** array
- **description:** Roles assigned to the user.
- – [RoleApiDTO](#)

loginProvider

- **type:** string
- **description:** Provider for the login
- **enum:** ['Local', 'LDAP']

type

- **type:** string
- **description:** type
- **enum:** ['DedicatedCustomer', 'SharedCustomer']

scope

- **type:** array
- **description:** List of scopes that the User is allowed to see
- – [GroupApiDTO](#)

features

- **type:** array
- **description:** List of features that the user is allowed to see
- – **type:** string

authToken

- **type:** string
- **description:** The secured user token

showSharedUserSC

- **type:** boolean

UtilizationApiDTO

Description

Model to describe a utilization change in the scenario

Optional Parameters**projectionDay**

- **type:** integer
- **format:** int32
- **description:** Projection day, indicate when to apply the change

target

- **description:** Target of the change, entity or group
- [BaseApiDTO](#)

percentage

- **type:** integer
- **format:** int32
- **description:** Utilization percentage change

VMEntityAspectApiDTO

Description**Inherits From**

This DTO inherits from [EntityAspect](#)

Optional Parameters**os**

- **type:** string

- **description:** The operating system type. E.G. 'Linux', 'Windows' and 'Unknown' if not found.

ip

- **type:** array
- **description:** The IP address. Can be IPv4 or IPv6
- – **type:** string

connectedNetworks

- **type:** array
- **description:** The connected Networks
- – **BaseApiDTO**

numVCPUs

- **type:** integer
- **format:** int32
- **description:** Number of vCPUs

coresPerSocketRatio

- **type:** integer
- **format:** int32
- **description:** Cores per socket ratio

processorPoolName

- **type:** string
- **description:** Processor Pool

ebsOptimized

- **type:** boolean
- **description:** EBS Optimized

sessions

- **type:** array
- **description:** Information about sessions established by a BusinessUser to this VirtualMachine.
- – **BusinessUserSessionApiDTO**

vendorToolsVersion

- **type:** string
- **description:** Vendor Tools Version

ahublicense

- **type:** boolean

VirtualDiskApiDTO

Description

Model to describe a Virtual Disk

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

tier

- **type:** string
- **description:** The tier of the Virtual Disk

actions

- **type:** array
- **description:** The related action: Move or Delete
- – [ActionApiDTO](#)

stats

- **type:** array
- **description:** The related statistics
- – [StatApiDTO](#)

attachedVirtualMachine

- **description:** The Virtual Machine if the disk is attached
- [BaseApiDTO](#)

provider

- **description:** The Storage provider
- [BaseApiDTO](#)

dataCenter

- **description:** The DataCenter where the VirtualDisk resides
- [BaseApiDTO](#)

environmentType

- **type:** string
- **description:** Environment type
- **enum:** ['CLOUD', 'ONPREM', 'HYBRID']

lastModified

- **type:** integer
- **format:** int64
- **description:** Last Modified

businessAccount

- **description:** Business Account
- [BaseApiDTO](#)

resourceGroup

- **description:** Resource Group
- [BaseApiDTO](#)

creationTime

- **type:** string
- **description:** Creation time

skuName

- **type:** string
- **description:** Sku name

snapshotId

- **type:** string
- **description:** Snapshot id

encryption

- **type:** string
- **description:** Encryption

attachmentState

- **type:** string
- **description:** Attachment state
- **enum:** ['AVAILABLE', 'IN_USE', 'UNKNOWN']

name

- **type:** string
- **description:** Name

ephemeral

- **type:** string
- **description:** Ephemeral

lastAttachedVm

- **type:** string
- **description:** Name of the VM this volume was last attached to.

numDaysUnattached

- **type:** string
- **description:** Number of days ago this volume was last attached.

hourlyBilledOps

- **type:** number
- **format:** double
- **description:** Average number of billed operations per hour.

attachedVMStorageCompatibility

- **type:** string
- **description:** Storage compatibility for virtualDisks's attached VM(s). The compatibility will affect scale analysis for the volume. If an attached VM is not PREMIUM compatible, the volume will never scale to a premium StorageTier
- **enum:** ['PREMIUM', 'STANDARD']

storageUsageType

- **type:** string
- **description:** Usage type for the volume, i.e., what the volume is used for.

- **enum:** ['SITE_RECOVERY', 'BACKUP', 'STANDARD']

VirtualDisksAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

virtualDisks

- **type:** array
- **description:** List of Virtual Disks
- – [VirtualDiskApiDTO](#)

VirtualVolumeEntityAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

files

- **type:** array
- **description:** Files comprised in the volume
- – **type:** string

WebhookApiDTO

Description

Inherits From

This DTO inherits from [WorkflowAspect](#)

Required Parameters

method

- **type:** string
- **description:** The http method used to make the request.
- **enum:** ['GET', 'POST', 'PUT', 'DELETE', 'PATCH']

url

- **type:** string
- **description:** The URL that HTTP request is made to.

Optional Parameters

template

- **type:** string
- **description:** The template for the body of request.

authenticationMethod

- **type:** string
- **description:** The authentication method to use for the request.
- **enum:** ['NONE', 'BASIC', 'OAUTH']

username

- **type:** string
- **description:** The username for the authenticated request.

password

- **type:** string
- **description:** The password for the authenticated request.

trustSelfSignedCertificates

- **type:** boolean
- **description:** If true, self-signed certificates will be trusted when using HTTPS connections. Defaults to 'false'.

headers

- **type:** array
- **description:** The request headers.

oauthData

WhereApiDTO

Description

Filter for entity or group queries.

Optional Parameters

relatedToScopes

- **type:** array
- **description:** Restrict to entities related to these scopes.
- **readOnly:** True
- – **type:** integer
- **format:** int64

conditions

- **type:** array
- **description:** Restrict to entities satisfying these conditions.
- **readOnly:** True
- – **ConditionApiDTO**

WidgetApiDTO

Description

Basic information of an entity

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

type

- **type:** string

scope

- **BaseApiDTO**

startPeriod

- **type:** string

endPeriod

- **type:** string

row

- **type:** integer
- **format:** int32

column

- **type:** integer
- **format:** int32

sizeRows

- **type:** integer
- **format:** int32

sizeColumns

- **type:** integer
- **format:** int32

widgetsetId

- **type:** integer
- **format:** int64

widgetElements

- **type:** array
- – [WidgetElementApiDTO](#)

WidgetElementApiDTO

Description

Basic information of an entity

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

row

- **type:** integer
- **format:** int32

column

- **type:** integer
- **format:** int32

type

- **type:** string

widgetId

- **type:** integer
- **format:** int64

properties

- **type:** object
- **additionalProperties:** {'type': 'string'}

stats

- **type:** array
- – [StatApiInputDTO](#)

datasets

- **type:** array
- – **type:** string

WidgetsetApiDTO

Description

Basic information of an entity

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

scope

- **type:** string

startPeriod

- **type:** string

endPeriod

- **type:** string

widgets

- **type:** array
- – [WidgetApiDTO](#)

category

- **type:** string

scopeType

- **type:** string

username

- **type:** string

isSharedWithAllUsers

- **type:** boolean

WorkflowApiDTO

Description

Model to describe a Workflow

Required Parameters

discoveredBy

- **description:** Target that discovered this workflow
- [TargetApiDTO](#)

type

- **type:** string
- **description:** The type of this workflow
- **enum:** ['UCSD', 'ACTION_SCRIPT', 'SERVICENOW', 'ACTIONSTREAM_KAFKA', 'WEBHOOK']

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

description

- **type:** string
- **description:** Description of the workflow

entityType

- **type:** string
- **description:** Type of the entity associated

actionType

- **type:** string
- **description:** Type of the action associated

parameters

- **type:** array
- **description:** Input parameters for the workflow
- – [InputFieldApiDTO](#)

scriptPath

- **type:** string
- **description:** Full path to workflow script (e.g. path to an ActionScript executable)

actionPhase

- **type:** string
- **description:** Action Phase to which workflow applies

timeLimitSeconds

- **type:** integer
- **format:** int64
- **description:** Time limit for workflow execution, in seconds

typeSpecificDetails

- **description:** The information about this workflow that is specific to its type.
- [WorkflowAspect](#)

WorkflowAspect

Description

Parent model to describe a type-specific workflow details

Required Parameters

type

- **type:** string

WorkflowOperationRequestApiDTO

Description

The details of the requested operation on the workflow.

Required Parameters

actionId

- **type:** integer
- **format:** int64
- **description:** The ID of the action that we perform the workflow operation on

operation

- **type:** string
- **description:** The operation that is being performed on the workflow
- **enum:** ['TEST']

WorkflowOperationResponseApiDTO

Description

Result of a workflow operation.

Required Parameters

succeeded

- **type:** boolean
- **description:** True if the workflow operation has succeeded.

Optional Parameters

uuid

- **type:** string

displayName

- **type:** string
- **description:** A user readable name of the api object. Cannot be blank. The UTF-8 encoding must be at most 255 bytes.

className

- **type:** string

details

- **type:** string
- **description:** Details of workflow operation result.

WorkloadControllerAspectApiDTO

Description

Inherits From

This DTO inherits from [EntityAspect](#)

Optional Parameters

controllerType

- **type:** string
- **description:** Information about workload controller type.
- **enum:** ['CRON_JOB_INFO', 'CUSTOM_CONTROLLER_INFO', 'DAEMON_SET_INFO', 'DEPLOYMENT_INFO', 'JOB_INFO', 'REPLICA_SET_INFO', 'REPLICATION_CONTROLLER_INFO', 'STATEFUL_SET_INFO']

customControllerType

- **type:** string
- **description:** Information about custom controller type. Only set when the controllerType is CUSTOM_CONTROLLER_INFO.

controllerReplicaCount

- **type:** integer
- **format:** int32
- **description:** The number of active replicas controlled by the workload controller.

Appendix: Entity Statistics

Turbonomic monitors the following statistics for entities in your environment:

ApplicationComponent Statistics

Heap

Produces

RemainingGcCapacity

ResponseTime

Threads

Transaction

VCPU

VMem

BusinessApplication Statistics

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

ResponseTime

Response time, measured in ms.

Transaction

Transactions per second

BusinessTransaction Statistics

Produces

ResponseTime

Transaction

BusinessUser Statistics

ActiveSessions

ImageCPU

ImageMem

ImageStorage

PoolCPU

PoolMem

PoolStorage

Produces

TotalSessions

Chassis Statistics

Cooling

Allocated cooling indicates the highest acceptable running temperature for a physical device, such as a chassis in a compute fabric.

Power

A measure of the power that is consumed by a physical device.

priceIndex

The degree of risk for the chassis.

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

Space

When known, the amount of physical hardware that can be used in conjunction with this entity. For example, the number of spaces in a server rack.

ContainerPlatformCluster Statistics

NumberConsumers

Produces

VCPU

VCPURequest

VMem

VMemRequest

ContainerPod Statistics

NumberConsumers
Produces
StorageAmount
VCPU
VCPULimitQuota
VCPURequest
VCPURequestQuota
VMem
VMemLimitQuota
VMemRequest
VMemRequestQuota
VStorage

ContainerSpec Statistics

Produces
VCPU
VCPURequest
VCPUThrottling
VMem
VMemRequest

Container Statistics

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

VCPU

The percentage utilization of the VCPU allocated for the hosting entity.

VCPULimitQuota

VCPURequest

VCPURequestQuota

VCPUThrottling

VMem

The percentage utilization of the VMem allocated to the hosting VM.

VMemLimitQuota

VMemRequest

VMemRequestQuota

DataCenter Statistics

Ballooning

Ballooning capacity, measured in KBytes. This capacity is the greater of 65% of the VMem configured for all powered-on VMs that the PM hosts, or the physical memory capacity

Cooling

Allocated cooling indicates the highest acceptable running temperature for a physical device, such as a chassis in a compute fabric.

CPU

Host CPU capacity, measured in MHz. This shows what percentage of CPU cycles are devoted to processing instructions.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

CPUAllocation

DESCRIPTION

CPUProvisioned

The aggregate Overprovisioned CPU capacity and utilization on the host, in KB. Capacity is a function of the overprovisioning percentage specified for the host.

HostLunAccess

HotStorage

IOThroughput

The data rate through the PM's IO adapters, measured in Kbytes per second.

Mem

The aggregate percentage of the PM's memory that is reserved or in use, measured in Kbytes.

MemAllocation

DESCRIPTION

MemProvisioned

Overprovisioned MEM capacity and utilization on the host, in KB. Capacity is a function of the overprovisioning percentage specified for the host.

NetThroughput

The aggregate data rate through the PM's network adapters

numCPUs

Host CPU capacity, measured in MHz. This shows what percentage of CPU cycles are devoted to processing instructions

numHosts

The number of hosts in the Datacenter

numSockets

The number of sockets in the Datacenter

Power

A measure of the power that is consumed by a physical device.

priceIndex

The degree of risk for the datacenter

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

Q16VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q1VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q2VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q32VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q4VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q64VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q8VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Space

When known, the amount of physical hardware that can be used in conjunction with this entity. For example, the number of spaces in a server rack.

StorageAccess

IOPS capacity and utilization

StorageLatency

Swapping

DESCRIPTION

DatabaseServer Statistics

Connection

DBCACHEHitRate

DBMem

priceIndex

Produces

ResponseTime

Transaction

TransactionLog

VCPU

VMem

VStorage

Database Statistics

costPrice

DESCRIPTION

DTU

LicenseAccess

priceIndex

The degree of risk for the database

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

StorageAmount

DesktopPool Statistics

ActiveSessions

CPUAllocation

ImageCPU

ImageMem

ImageStorage

MemAllocation

PoolCPU

PoolMem

PoolStorage

priceIndex

Produces

TotalSessions

DiskArray Statistics

Extent

priceIndex

Produces

IOModule Statistics

Cooling

Allocated cooling indicates the highest acceptable running temperature for a physical device, such as a chassis in a compute fabric.

NetThroughput

The data rate through the entity's network adapters, measured in Kbytes/second

PortChannel

DESCRIPTION

Power

A measure of the power that is consumed by a physical device.

priceIndex

The degree of risk for the IO Module

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

LogicalPool Statistics

DiskArrayAccess

Extent

priceIndex

Produces

StorageAccess

StorageAmount

StorageLatency

StorageProvisioned

Namespace Statistics

priceIndex

Produces

VCPU

VCPULimitQuota

VCPURequest

VCPURequestQuota

VMem

VMemLimitQuota

VMemRequest

VMemRequestQuota

PhysicalMachine Statistics

Ballooning

Ballooning capacity, measured in KBytes. This capacity is the greater of 65% of the VMem configured for all powered-on VMs that the PM hosts, or the physical memory capacity.

Cooling

CPU

CPU capacity, CPU reserved, and CPU utilized, in MHz.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

CPUAllocation

CPU capacity, as allocated to the host, in MHz.

CPUProvisioned

Overprovisioned CPU capacity and utilization on the host, in MHz. Capacity is a function of the overprovisioning percentage specified for the host.

HostLunAccess

IOThroughput

Capacity and utilization of data rate through the host's IO adapter, measured in Kbits/sec.

Mem

The percentage of the PM's memory that is reserved or in use, measured in Kbytes.

MemAllocation

Allocation and utilization of host memory, measured in KB.

MemProvisioned

Overprovisioned MEM capacity and utilization on the host, in KB. Capacity is a function of the overprovisioning percentage specified for the host.

NetThroughput

Capacity and utilization of data rate through the host's Network adapter, measured in Kbits/sec.

numCPUs

The number of CPUs on the host.

numSockets

The number of sockets discovered on this host.

Power

priceIndex

The degree of risk for the host.

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

Q16VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q1VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q2VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q32VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q4VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Q64VCPU

Q8VCPU

Ready queue capacity and wait time, measured in ms. Turbonomic monitors 1-CPU, 2-CPU, 4-CPU, up to 32-CPU ready queues.

Space

StorageAccess

StorageLatency

Swapping

The capacity, reserved capacity, and utilization for rate of memory swapping to disk, in bits per second.

Service Statistics

NumberReplicas

priceIndex

Produces

StorageController Statistics

priceIndex

The degree of risk for the disk array.

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

StorageAmount

The storage capacity, reserved storage, and utilized storage for this entity's storage in MB

Storage Statistics

Extent

priceIndex

The degree of risk for the storage entity.

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

StorageAccess

IOPS capacity and utilization

StorageAmount

The storage capacity, reserved storage, and utilized storage for this entity in MB

StorageLatency

The capacity, reserved amount, and utilized amount of latency for storage transactions, in msec.

StorageProvisioned

Overprovisioned storage capacity and utilization on the entity, in MB. Capacity is a function of the overprovisioning percentage specified for the entity.

Switch Statistics

NetThroughput

The data rate through the entity's network adapters, measured in Kbytes/second.

PortChannel

The data rate through the port channel, measured in Kbytes/second.

priceIndex

The degree of risk for the Switch.

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

ViewPod Statistics

ActiveSessions

priceIndex

Produces
TotalSessions

VirtualDataCenter Statistics

CPUAllocation

Host CPU capacity, measured in MHz. This shows what percentage of CPU cycles are devoted to processing instructions

MemAllocation

DESCRIPTION

priceIndex

The degree of risk for the virtual datacenter

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

VirtualMachine Statistics

Ballooning

Ballooning capacity, measured in KBytes. This capacity is the greater of 65% of the VMem configured for all powered-on VMs that the PM hosts, or the physical memory capacity

CPU

Host CPU capacity, measured in MHz. This shows what percentage of CPU cycles are devoted to processing instructions

The percentage utilization of the VCPU allocated for the hosting VM.

CPUAllocation

DESCRIPTION

CPUProvisioned

Overprovisioned CPU capacity and utilization on the entity, in Mhz. Capacity is a function of the overprovisioning percentage specified for the entity.

IOThroughput

DESCRIPTION

Mem

The percentage of the PM's memory that is reserved or in use by the VM, measured in Kbytes.

The percentage utilization of the VMem allocated by the host.

MemAllocation

DESCRIPTION

MemProvisioned

Overprovisioned Mem capacity and utilization on the entity, in Kbytes. Capacity is a function of the overprovisioning percentage specified for the entity.

NetThroughput

The data rate through the entity's network adapters, measured in Kbytes/second

numVCPUs

DESCRIPTION

priceIndex

The degree of risk for the Virtual Machine

Produces

Not Implemented: The number of entities connected to this provider, used in calculating pricing.

StorageAccess

IOPS capacity and utilization

StorageAmount

The storage capacity, reserved storage, and utilized storage for this entity's storage in MB

StorageLatency

DESCRIPTION

StorageProvisioned

Overprovisioned storage capacity and utilization on the entity, in MB. Capacity is a function of the overprovisioning percentage specified for the entity.

Swapping

DESCRIPTION

VCPU

The percentage utilization of the VCPU allocated for the hosting VM.

VMem

The percentage utilization of the VMem allocated by the host.

VStorage

Virtual storage allocated to a VM, measured in Kbytes.

VirtualVolume Statistics

costPrice

IOThroughput

Produces

StorageAccess

StorageAmount

StorageLatency

StorageProvisioned

WorkloadController Statistics

priceIndex

Produces

VCPULimitQuota
VCPURequestQuota
VMemLimitQuota
VMemRequestQuota

Appendix: API Change History

Each major release of Turbonomic includes fixes issues and improvements to the API. This section lists these changes for each major release.

Note:

We implement deprecations in point releases of Turbonomic. For example, assume we set the End of Life (EOL) for some API features at 8.4.3. In that case, you would see the deprecations linked here in the entry for 8.5.0, along with the list of all other fixes and improvements we made in the 8.4.x point releases. To see the latest deprecation history, go to [Appendix: API Deprecation History](#).

Turbonomic 8.6.0 API Fixes and Improvements

- **Improvement:**

The API now includes the Plan Destinations endpoint.

A plan destination is an external resource where plan results can be uploaded. Currently, you can upload the results of a 'Migrate to Cloud' plan to the Azure Migrate portal. Use the Plan Destinations endpoint to get plan destinations and run uploads.

- **Improvement:**

When deleting a reservation, you can now specify whether to permanently delete that reservation.

The API now includes the new `reservation_force_delete` parameter that you can pass along with a DELETE call to a specific reservation. When `reservation_force_delete = true`, the system removes the reservation permanently, no matter what state it is in. Before this release, a reservation that you deleted via the API or user interface continued to display for deletion, and was only permanently deleted after 48 hours.

- **Improvement:**

The API includes a new LABEL commodity type.

The `commodityType` enum includes a new LABEL commodity type.

- **Improvement:**

For API developers, when a reservation you create fails, the returned DTO includes more data about the failure.

When you create a reservation, and the reservation fails, the API returns a DTO to explain the cause of the failure. This DTO includes new fields:

- `timespan`: Indicates whether the reservation calculation was based on realtime or historical resource utilization data. Can be one of:
 - `Current`: The calculations were based on realtime utilization data
 - `Historical`: The calculations were based on historical utilization
- `cluster`: The name of the cluster that came the closest to being able to provide the resources that the reservation needed.
- `hrefCluster`: A link to stats for the closest-seller cluster.
- `hrefEntity`: A link to stats for the closest-seller entity that is a member of the closest-seller cluster.

For example, the DTO can include data similar to the following for a placement failure:

```
"placements": {
  "failureInfos": [
    {
      "resource": "StorageAmount",
      "timespan": "Historical",
      "closestSeller": {
        "uuid": "74167780552264",
        "displayName": "QSGRID01:DC6DS2",
        "className": "Storage",
        "cluster": "StorageCluster-A",
        "hrefEntity": "/reservations/stats/74167780552264",
        "hrefCluster": "/reservations/stats/74167780552265"
      },
      "maxQuantityAvailable": 248294.59024047852,
      "quantityRequested": 273184.5625,
      "units": "MB"
    }
  ]
}
```

- **Improvement:**

Handling of non-executable actions has been improved.

This release improves the handling of actions that are currently not executable due to prerequisite actions.

For example, in order to suspend Host A, VM_01 in the host must first move to Host B. However, Host B only has capacity for one VM and is currently hosting VM_02. In this case, Host A suspension is blocked by two prerequisite actions – VM_02 moving to another host and VM_01 moving to Host B.

The Action Details page for the main action (Host A suspension in the example) now shows the following information:

"Blocked by actions on target or destination that need to be executed first."

For earlier releases, the Action Details page indicated that the action is blocked by a policy.

For API developers, the ActionApiDTO now shows this state. Turbonomic sets the BLOCKED_BY key of the relatedActionsCountByType parameter to 0, which indicates that an action is currently not executable due to prerequisite actions.

When all the prerequisite actions have been executed, the main action becomes executable.

- **Improvement:**

When you examine a failed reservation via the API, the data now returns a reason for the failure.

After you create a reservation, you can GET the reservations endpoint for data about the current reservations in your environment. The resulting data includes a status. If the status is PLACEMENT_FAILED, Turbonomic could not place all the workloads in the reservation for some reason. Starting with version 8.5.4, the placements field in the data includes invalidInfo to give a reason for the placement failure. The reason can be:

- MARKET_CONNECTIVITY_ERROR: The reservation process could not connect to the Market component for some reason.
- MARKET_NOT_READY: The market does not have data from the Headroom plans for the given reservation scope.
- INVALID_CONSTRAINTS: The reservation policies include conflicting or invalid constraints.

For example, the data for a single reservation could include the following data:

```
"demandEntities": [
  {
    "template": {
      "uuid": "215167980658768",
      "displayName": "MyVmTemplate",
      "className": "VirtualMachineProfile"
    }
  }
]
```

```

    },
    "placements": {
      "invalidInfo": {
        "invalidReason": "MARKET_CONNECTIVITY_ERROR"
      }
    }
  }
]

```

Turbonomic 8.5.0 API Fixes and Improvements

- **Fixed Issue:**

The GET /entities/{entity_Uuid}/groups endpoint is not included in the Swagger UI.

The Swagger documentation does not include an entry for the endpoint, GET /entities/{entity_Uuid}/groups.

- **Fixed Issue:**

When you create groups with a case-insensitive filter, the group results can be unexpected.

For API scripts that create groups, if you set `caseSensitive = false` for a regex filter, the results can be unexpected. The group creation can fail, or you can create a group that does not contain the entities you expect. For example:

- **Fixed Issue:**

Under some circumstances, the search endpoint can arbitrarily fail to return data.

Because of timing issues when updating cached group data, calls to the search endpoint can fail to return data.

Turbonomic 8.4.0 API Fixes and Improvements

- **Improvement:**

For Dynatrace, you can now enable or disable collection of VM metrics via the Dynatrace target.

When managing applications, analysis takes VM metrics into account. In a Dynatrace environment, Turbonomic can discover VM data from the Dynatrace target and also from the underlying VMs. If it collects VM data from both sources, analysis will use the Dynatrace data.

For most environments it is best to use the VM data that Turbonomic collects directly from the VMs themselves. The data can be richer and more accurate, and discovery of this data through Dynatrace can experience unsatisfactory performance.

To give you control over the source of VM metric data that analysis will use, this release introduces the **Collect Virtual Machine Metrics** setting when you configure a Dynatrace target. By default, this setting is **Off**. In that case, Turbonomic does not collect VM metrics via the Dynatrace target, and analysis uses data collected from the VMs themselves.

Note:

If you turn this setting **On** for the target, then analysis does not use the percentiles that you configure in the **Aggressiveness** settings for the affected VMs.

When you configure a Dynatrace via the API, you can now use the optional setting:

```

{
  "displayName": "Collect Virtual Machine Metrics",
  "name": "collectVmMetrics",
  "value": "false",
  "defaultValue": "false",
  "isMandatory": false,
  "isSecret": false,
  "isMultiline": false,
  "isTargetDisplayName": false,
  "valueType": "BOOLEAN",
  "description": "Overwrite Hypervisor or Cloud Provider Virtual Machine metrics with data from the target",
}

```

```
"verificationRegex": "(true|false)"
}
```

- **Improvement:**

This release includes the Minimum Wasted File Size setting for Wasted File policies.

When it discovers wasted files, Turbonomic identifies a given storage, plus the list of wasted files on it. In some circumstances, if the volume has many files, the data to describe the volume is too large to transport from the target back to Turbonomic. In that case, analysis can fail to include the affected storage, and the log can post an error that includes the string (where * is a wildcard):

```
BroadcastStage.*Entity.*failed to be broadcast because it's too large
```

To reduce the data payload for that storage, you can direct wasted storage browsing to skip over files of a minimum size. Then the data only includes larger files in its list, which can reduce the overall payload. The default minimum is 1 MB.

If you continue to see this problem, you can increase the size of wasted files to add into the list. That should reduce the number of wasted files on a volume. To adjust the **Minimum Wasted Files Size** setting:

1. Configure a Storage Policy.

Navigate to **Settings** and choose **Policies**. Then edit or create a new Storage automation policy.

2. Edit the Minimum Wasted Files Size setting.

In the **Storage Settings** section, edit the value for **Minimum Wasted Files Size**.

When editing policies via the API, you can find this setting in the storage settings manager (...api/v3/settings/specs?manager_uuid=storagesettingsmanager). The setting is defined as:

```
{
  "uuid": "minWastedFilesSize",
  "displayName": "Minimum Wasted Files Size [KB]",
  "defaultValue": "1000.0",
  "valueType": "NUMERIC",
  "valueObjectType": "String",
  "min": 0,
  "max": 10000000000,
  "entityType": "Storage"
}
```

- **Fixed Issue:**

When you execute a POST stats/uuid call with no groupBy setting, the API sometimes returns grouped stats.

For a POST: .../stats/{statistic_Uuid} call to the API, you can specify groupBy parameters for the statistics you want to get. If you do not provide any groupBy values, the API should return ungrouped stats records. However, under some circumstances it does return grouped records. The API should be consistent.

- **Fixed Issue:**

Executing a GET on the businessunits endpoint can return data even if there are no businessunit entities in the given scope.

Executing a GET on the businessunits endpoint can return data even if there are no businessunit entities in the given scope. The data it returns is an array with a single element in it. For example:

```
[{"master":false,"riSupported":false,"hasRelatedTarget":false}]
```

The proper response for this circumstance should be an empty array.

Turbonomic 8.3.0 API Fixes and Improvements

- **Improvement:**

The Stats that the API returns for a VStorage entity now include the volume name in the displayName field.

When you get stats for a VStorage entity, the returned data now includes the volume name in the displayName field. In previous versions the API returned the entity's key value for displayName.

- **Improvement:**

New stats fields for a cloud scope.

When a /stats request is executed for a cloud scope, the following four fields will be returned when applicable to summarize savings and investments:

- **REALIZED_SAVINGS:**

Savings from executed efficiency actions.

- **REALIZED_INVESTMENTS:**

Investments from executed performance actions.

- **MISSED_SAVINGS:**

Potential savings from recommended efficiency actions that were not taken.

- **MISSED_INVESTMENTS:**

Potential investments from recommended performance actions that were not taken.

- **Improvement:**

The LicenseApiDTO now includes the customerId parameter.

Starting with Turbonomic 8.2.3, LicenseApiDTO includes the customerId parameter, a unique identifier for the licensed customer. This ID is intended to match the same customer to multiple licenses. For example, if one customer runs two Turbonomic instances each with its own license, the customerId will be the same for both.

- **Fixed Issue:**

For accepted values in the FilterApiDTO object, the Swagger UI did not list RXEQ or RXNEQ as valid match types.

When you specify filters, you can specify Equals (RXEQ) or Not Equals (RXNEQ) for REGEX values. The Swagger UI now includes these as allowable values in its explanation. The values you can specify are:

- For Strings

'EQ', 'NEQ', 'RXEQ', 'RXNEQ'

- For Numbers

'EQ', 'NEQ', 'GT', 'LT', 'GTE', 'LTE'

- **Fixed Issue:**

For a list of actions, filter by Instance Type does not work for Optimization actions.

When you view a list of actions, you can filter by different criteria, including Instance Type. However filtering by Instance Type does not work for Optimization actions.

- **Fixed Issue:**

Search filters that include Not Equals criteria can return incorrect results.

When you set up search criteria that use a Not Equals operator, the results can be incorrect.

- **Fixed Issue:**

When you use the API to get the "numVMs" stats for an unsupported scope, the API returns a value of zero.

When you execute the `api/v3/stats?ascending=true` request, you typically set a scope for the request. When requesting the `numVMs` stat, the scope must be a cluster. If you set a different type of scope, the data returns zero for the number of VMs. This is misleading, because it implies that there are no VMs in that scope. Instead, the returned value should indicate that you used an invalid scope.

- **Fixed Issue:**

Using the API to get the Global Defaults policy returns invalid data.

To query for the Global Defaults policy, you can use the following request:

```
api/v3/settingspolicies/55555
```

However, this request returns an invalid payload, with no policy data in it.

- **Fixed Issue:**

After the licensed workload capacity has been exceeded, you can still add targets via the API.

Turbonomic licensing specifies the number of workloads you can manage via targets. However, if you exceed the licensed capacity of workloads, you can still add new targets via the API, which increases the workload count.

Turbonomic 8.2.0 API Fixes and Improvements

- **Fixed Issue:**

Under some circumstances, when creating large groups the API returns a 500 error and generates the following log entry:

```
ERROR [grpc-default-executor-22959] [GroupRpcService] : Cannot find groups with ids
```

- **Fixed Issue:**

The `GET /supplyChains` request no longer returns an entity level of information when `compact` is passed in the request.

- **Fixed Issue:**

When providing an invalid `ScenarioApiInputDTO` for scenario creation, the API will return an appropriate error. Instead, the API returned 200 with an invalid Scenario UUID.

- **Fixed Issue:**

Due to an issue with the generated Swagger DTO hierarchy, parsing the result of the `GET actions/uuid/details` request would cause an error to be generated. This error will no longer occur, and the request will complete successfully.

- **Fixed Issue:**

A request for `/reservations/stats/uuid` can return values for Reserved VMs that have been deployed.

After using the API to deploy the VMs in a reservation, Turbonomic keeps a record of those VMs and their reservations for 48 hours. When you get stats for reserved VMs, the API incorrectly includes values for these deployed VMs. The actions that Turbonomic recommends are correct, but reporting on provider statistics can be incorrect.

- **Fixed Issue:**

When you view a density chart (e.g. VMs over Host Density), the chart should roll data up into the appropriate data points. For example, for hourly data, it should not also include ten-minute data points. However, the chart display mixes these data point types.

- **Fixed Issue:**

API response times have been improved when sending a query that returned entity stats against the `StorageAmount` metric.

- **Fixed Issue:**

For the `/targets/{targetUuid}/health` request, the state parameter enum has the following values and descriptions:

– NORMAL (1):

This entity is in a healthy state.

– MINOR (2):

The recommended action will improve the environment, but is unlikely to have severe consequences if not addressed.

– MAJOR (3):

The recommended action will improve the environment, and if left unaddressed is likely to have severe consequences.

– CRITICAL (4):

The recommended action will improve the environment, and if left unaddressed *will* have severe consequences. These actions should be addressed immediately.

• **Known Issue:**

The `limitEntities` parameter in the `ActionScopesApiInputDTO` is ignored in the `POST /actions` and `POST /actions/stats` requests. In the `POST /actions` request, this functionality is handled by pagination.

• **Improvement:**

In the `marketsettingsmanager` settings manager, the settings `minReplicas` and `maxReplicas` have been added, which enable you to specify the minimum and maximum replicas for application component horizontal scaling.

• **Improvement:**

The `getActionDetailType` parameter has been added to the `ActionDetailsApiDTO`. This parameter will return the action type of the requested action.

• **Improvement:**

To assign the Report Editor privilege to a user account, you can use the API. For example, you can create a user with Report Editor privileges with the following API payload:

```
{
  "username": "MyUserName",
  "password": "MyPassword",
  "type": "DedicatedCustomer",
  "loginProvider": "LOCAL",
  "roles": [{ "name": "report_editor" }, { "name": "advisor" }]
}
```

In this example, the `roles` field is an array of roles that includes the `report_editor` role. If you need help using the API, please contact your support representative.

• **Improvement:**

The data returned from any requests for ENTITIES includes aspects. Under circumstances where there is no value for the following aspects, the DTO does not include the given aspect:

– `aspects.dbAspect.maxConcurrentSessions`

– `aspects.dbAspect.maxConcurrentWorkers`

• **Improvement:**

The API now includes the new `reservation_deployed` parameter that you can pass along with a DELETE call to a specific reservation. This enables Turbonomic to correctly track resource utilization on the affected providers.

When you delete a reservation via the API, and you include the `reservation_deployed = true` parameter, the following things happen:

- Turbonomic analysis is aware of the newly deployed workloads on the providers, and tracks those VMs as usual.
- The reservation remains in the Turbonomic for 48 hours. If you inspect this reservation via the API or the user interface, the reservation appears unchanged.
- After 48 hours, Turbonomic deletes the reservation.

• **Improvement:**

This version of Turbonomic introduces a new Global Default setting, `Enable analysis of on-prem Virtual Volume`. This setting enables the product to generate the commodities and perform the analysis required to execute actions on individual virtual volumes.

Note:

We offer this feature as a public preview. Feature details might be subject to change.

This version of Turbonomic introduces a new boolean setting to the `marketsettingsmanager` settings manager, `onPremVirtualVolumeResourceAnalysis`. This global setting defaults to false, and when enabled, the product will generate the commodities and perform the analysis required to execute actions on individual virtual volumes.

• **Improvement:**

The action DTO now includes the related cluster in the `connectedEntities` object for each of the Current, the New, and the Target entities in the action description. In the DTO, the cluster object is similar to:

```
"connectedEntities": [
  {
    "className": "Cluster",
    "displayName": "ACM/ACM Cluster",
    "uuid": "73856545920539"
  }
]
```

• **Improvement:**

In the `DemandReservationApiDTO`, the `relatedResources` parameter has been deprecated and replaced by the `linkedResources` parameter. This parameter returns more detailed information about the reservation resources.

• **Improvement:**

When at least one of the parameters `orderBy`, `limit`, or `cursor` are included with the `GET /tags` request, the results will be paginated.

Without these parameters, the results will be returned in full.

• **Improvement:**

The `Provision` setting for scaling actions has been replaced with the `Horizontal Scaling` setting. In addition, the following items must be true to horizontally scale applications:

- The application must be horizontally scalable and reside on a Kubernetes target
- The application must have `Transaction` or `ResponseTime` metrics
- `Transaction SLO` or `Response Time SLO` must be enabled

• **Improvement:**

When at least one of the parameters `orderBy`, `limit`, or `cursor` are included with the `GET /search`, `POST /search`, and `GET /groups` requests, the results will be paginated. Without these parameters, the results will be returned in full.

In addition, the `environmentType` and `cloudType` parameters for empty groups will be set to the values of the target(s) that initially discovered them.

Appendix: API Deprecation Contract

The following endpoints, requests, DTOs, and parameters are deprecated in the Turbonomic API. The End of Life (EOL) gives the product version in which we will finalize these changes, and will no longer offer the deprecated items.

Note:

See the instructions for alternative usage for deprecated items with a defined EOL.

EOL: Not Determined

We deprecate the following features, but we have not determined which Turbonomic version marks their End of Life.

Endpoints	None
Requests	None
Request Parameters	None
DTOs	<ul style="list-style-type: none">• DTO: ScenarioChangeApiDTO Instruction: Use the loadChanges or configChanges parameters in the ScenarioApiDTO.
DTO Parameters	<ul style="list-style-type: none">• DTO: ScenarioApiDTO Parameter Name: changes Instruction: Use the loadChanges or configChanges parameters.

EOL: 8.6.1

Behavior Changes:

- Pagination of Returned Data from /search requests:

For searches, the API paginates the returned data. If you do not specify a pagination limit, then the API returns pages set to the default limit. Starting with version 8.6.1, the default and max pagination limits for search data will be 500. You can set pagination to less than 500, but if your search results include more than 500 entries, the results will be paginated. Your scripts should always check for a pagination cursor when processing search results.

We will make the following deprecation changes in the 8.6.1 release. These deprecated features will be removed from the API at that time.

Endpoints	None
Requests	None
Request Parameters	None
DTOs	<ul style="list-style-type: none">• ReportScheduleApiDTO This release will remove ReportScheduleApiDTO.
DTO Parameters	<ul style="list-style-type: none">• DTO: ActionApiDTO Parameter Name: CurrentLocation Instruction: The object in this parameter will only contain the following fields:

	<ul style="list-style-type: none"> – links – uuid – className – displayName – discoveredBy – environmentType – vendorIDs
	<ul style="list-style-type: none"> • DTO: ActionApiDTO <p>Parameter Name: NewLocation</p> <p>Instruction: The object in this parameter will only contain the following fields:</p> <ul style="list-style-type: none"> – links – uuid – className – displayName – discoveredBy – environmentType – vendorIDs • DTO: ProductVersionDTO <p>Parameter Name: buildUser</p> <p>Instruction: Deprecated with no replacement. This parameter was not set in the 8.x product family.</p> • DTO: GroupApiDTO <p>Parameter Name: remoteId</p> <p>Instruction: Deprecated with no replacement. This parameter was not set in the 8.x product family.</p> • DTO: UserApiDTO <p>Parameter Names:</p> <ul style="list-style-type: none"> – roleUuid – roleName <p>Instruction: Deprecated. Use the roles parameter in UserApiDTO.</p>

EOL: 8.7.1

We will make the following deprecation changes in the 8.7.1 release. These deprecated features will be removed from the API at that time.

Endpoints	None
Requests	<ul style="list-style-type: none">• DELETE /entities/<entityId>/tags/<tagKey> Instead, use DELETE /entities/<entityId>/tags?key=<tagKey>• DELETE /groups/<groupId>/tags/<tagKey> Instead, use DELETE /groups/<groupId>/tags?key=<tagKey>
Request Parameters	None
DTOs	<ul style="list-style-type: none">• LicenseApiInputDTO Instruction: Use LicenseApiDTO.
DTO Parameters	<ul style="list-style-type: none">• DTO: HttpProxyDTO Parameter Name: portNumber Instruction: Use proxyPortNumber.• DTO: LogEntryApiDTO Parameter Name: reasonCommodity Instruction: Use the array, reasonCommodities.

EOL: 8.8.1

We will make the following deprecation changes in the 8.8.1 release. These deprecated features will be removed from the API at that time.

Endpoints	None
Requests	<ul style="list-style-type: none">• GET /search/market/ Instead, use GET /markets• GET /search/target/ Instead, use GET /targets• GET /groups/<groupId>/actions/<actionId> Do not use this call.• GET, POST /target/<targetId>/stats Do not use this call.• GET /businessunits/<busUnitId>/stats Instead, use GET /entities/<entityId>/stats or GET /stats/<entityId>/stats. These calls use the business unit entity ID.• POST /businessunits/<busUnitId>/stats Instead, use POST /stats/<entityId>/stats or POST /stats.
Request Parameters	None

DTOs	None
DTO Parameters	None
ENUM Values	<ul style="list-style-type: none"> • entityType:VMSpec Use VirtualMachineSpec instead • entityTypes:VMSpec Use VirtualMachineSpec instead • entityTypeFilter:VMSpec Use VirtualMachineSpec instead • providerEntityType:VMSpec Use VirtualMachineSpec instead • relatedEntityType:VMSpec Use VirtualMachineSpec instead • providerType:VMSpec Use VirtualMachineSpec instead

Appendix: API Deprecation History

The following endpoints, requests, DTOs, and/or parameters have been deprecated in the Turbonomic API. The End of Life (EOL) gives the product version in which we finalized these changes, and no longer support the deprecated items.

EOL: 8.5.1

Behavior Changes:

- Pagination of Returned Data

The default pagination will change for the following requests:

- GET /groups
- GET /groups/<groupId>/members
- GET /groups/<groupId>/entities
- GET /targets/<targetId>/entities
- GET /tags
- GET /tags/{tagKey}/entities

To paginate returned data, the `limit`, `orderBy`, and `cursor` parameters control how the APIs paginate their data. Currently if you specify any one of these parameters, the API paginates the returned data. If you do not specify any of these parameters, the API does not paginate the output, and it returns an unlimited set of data.

Starting with version 8.5.1, if you do not specify a `limit` for these requests, the API will paginate the data to a default limit. If your scripts make these requests without setting a limit, you should update them to check for a pagination cursor in the returned data.

We made the following deprecation changes in the 8.5.1 release. These deprecated features were removed from the API at that time.

Endpoints	None
Requests	<ul style="list-style-type: none"> Request: GET /users/onetimepassword <p>Instruction: Deprecatcd with no replacement. This is not required for any Turbonomic activities.</p>
Request Parameters	None
DTOs	None
DTO Parameters	None

EOL: 8.4.3

We made the following deprecation changes in the 8.4.3 release. These deprecated features were removed from the API at that time.

Endpoints	None
Requests	None
Request Parameters	<ul style="list-style-type: none"> Request: GET /search <p>Parameter Name: regex</p> <p>Instruction: Use the queryType parameter.</p>
DTOs	<ul style="list-style-type: none"> DTO: StatPercentileApiDTO <p>Instruction: Use StatHistUtilizationApiDTO.</p>
DTO Parameters	<ul style="list-style-type: none"> DTO: ActionApiDTO <p>Parameter Name: resizeToValue</p> <p>Instruction: Use the newValue parameter.</p> <ul style="list-style-type: none"> DTO: ActionScopesApiDTO <p>Parameter Name: limitEntities</p> <p>Instruction: Use the limit parameter.</p> <ul style="list-style-type: none"> DTO: BillingFamilyApiDTO <p>Parameter Name: uuidToNameMap</p> <p>Instruction: Use the businessUnitApiDTOList parameter.</p> <ul style="list-style-type: none"> DTO: BusinessUnitApiDTO <p>Parameter Name: hasRelatedTarget</p> <p>Instruction: Use the associatedTargetId parameter.</p> <ul style="list-style-type: none"> DTO: ScopeUuidsApiInputDTO <p>Parameter Name: topologyContextId</p> <p>Instruction: Use the marketId parameter.</p> <ul style="list-style-type: none"> DTO: StatApiDTO <p>Parameter Name: percentile</p> <p>Instruction: Use the histUtilizations parameter.</p> <ul style="list-style-type: none"> DTO: TargetApiDTO

	<p>Parameter Name: currentBusinessAccount</p> <p>Instruction: Use the associatedTargetId parameter of the BusinessUnitApiDTO.</p>
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