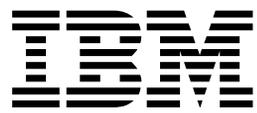


IBM Cloud Orchestrator  
Version 2.5

*Content Development Guide*



**Note**

Before using this information and the product it supports, read the information in Notices.

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# Contents

<b>Preface</b> . . . . .	<b>v</b>	<b>Chapter 7. Automating the creation of categories, offerings, and instance actions.</b> . . . . .	<b>25</b>
Who should read this information . . . . .	v	Exporting by using the catalogTool.sh tool . . . . .	28
<b>Chapter 1. Getting started with IBM Cloud Orchestrator content</b> . . . . .	<b>1</b>	<b>Chapter 8. Publishing IBM Cloud Orchestrator content to IBM Cloud Orchestrator Catalog.</b> . . . . .	<b>29</b>
Content packs . . . . .	1	<b>Appendix A. SCOrchestrator_Toolkit</b> ..	<b>31</b>
Virtual images . . . . .	1	Business objects . . . . .	32
<b>Chapter 2. IBM Cloud Orchestrator overview</b> . . . . .	<b>3</b>	OperationContext . . . . .	32
Architecture . . . . .	3	Service Instance . . . . .	33
<b>Chapter 3. Installing and configuring the IBM Process Designer</b> . . . . .	<b>5</b>	VirtualMachine . . . . .	33
<b>Chapter 4. Developing toolkit and application content</b> . . . . .	<b>7</b>	NetworkInterface . . . . .	34
Implementing workflow orchestration . . . . .	7	Services . . . . .	34
Managing business processes . . . . .	7	General system services . . . . .	35
Process application . . . . .	8	Integration services . . . . .	36
Toolkit . . . . .	8	Cloud management services . . . . .	41
Snapshot . . . . .	8	Samples . . . . .	42
Business Process Definition . . . . .	9	<b>Appendix B. Scripting utilities toolkit</b> <b>45</b>	
Service . . . . .	9	File upload restrictions . . . . .	45
Participant group . . . . .	10	Business objects . . . . .	45
Coach validation framework. . . . .	10	Implementation services . . . . .	47
Implementing extensions with IBM Cloud Orchestrator . . . . .	11	Sample processes . . . . .	53
Implementing a custom operation for IBM Cloud Orchestrator . . . . .	11	Sample UIs . . . . .	54
Start a custom extension operation . . . . .	12	<b>Appendix C. Support IaaS toolkit</b> . . . . .	<b>55</b>
Using instance data provided by OperationContext . . . . .	13	Generic IaaS REST call. . . . .	56
Implementation of a human service as a UI extension . . . . .	13	OpenStack and Cloud API library in Business Process Manager . . . . .	57
Implementation a Business Process Manager process as an extension . . . . .	14	Get IaaS Regions . . . . .	57
Best practices and guidelines . . . . .	15	Samples for the IaaS support toolkit . . . . .	58
Importing and exporting toolkits and process applications . . . . .	17	Sample to create a tenant in OpenStack identity service . . . . .	59
Importing toolkits . . . . .	17	Sample to get a list of servers from OpenStack compute service . . . . .	59
Exporting toolkits . . . . .	18	Troubleshooting . . . . .	60
Business Process Manager security . . . . .	18	<b>Appendix D. Email notification toolkit</b> <b>61</b>	
<b>Chapter 5. Importing by using the command-line interface</b> . . . . .	<b>19</b>	Business objects . . . . .	61
<b>Chapter 6. Example scenarios for workflow-based orchestration.</b> . . . . .	<b>21</b>	Implementation services . . . . .	62
Self-service offerings scenario . . . . .	21	Sample processes . . . . .	63
		Sample UI. . . . .	63
		<b>Appendix E. OpenStack Cinder Storage Volumes toolkit</b> . . . . .	<b>65</b>
		Installing and configuring . . . . .	65
		Toolkit scenarios. . . . .	65
		Creating new volumes. . . . .	66
		Attaching volumes . . . . .	66
		Detaching volumes . . . . .	68

Deleting volumes . . . . .	68
Managing volumes related to a virtual system instance . . . . .	69
Toolkit developer's reference. . . . .	70
Environmental variables . . . . .	70
Business objects . . . . .	70
Human services . . . . .	71
Coach views . . . . .	71
Business processes . . . . .	72
Integration services. . . . .	73
Samples about how to use the available services and views . . . . .	74
Importing XML into IBM Cloud Orchestrator . . . . .	75
Troubleshooting . . . . .	76
<b>Appendix F. OpenStack Services toolkit</b>	<b>79</b>
Configuring . . . . .	79
Toolkit scenarios. . . . .	80
Deploying a Linux virtual machine . . . . .	80
Deploying a Linux virtual machine with approval and notification. . . . .	81
Deploying a Windows virtual machine . . . . .	82
Deploying a LAMP stack using multitiered technology. . . . .	82

<b>Accessibility features for IBM Cloud Orchestrator . . . . .</b>	<b>85</b>
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<b>Notices . . . . .</b>	<b>87</b>
Programming interface information . . . . .	89
Trademarks . . . . .	89
Terms and conditions for product documentation..	89
IBM Online Privacy Statement . . . . .	90

<b>Glossary . . . . .</b>	<b>91</b>
A. . . . .	91
B. . . . .	92
C. . . . .	92
E. . . . .	92
H. . . . .	92
K. . . . .	92
P. . . . .	92
R. . . . .	93
S. . . . .	93
T. . . . .	93
V. . . . .	94

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## **Preface**

This publication documents how to author content for IBM® Cloud Orchestrator.

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### **Who should read this information**

This information is intended for users and cloud administrators who build content by using the IBM Cloud Orchestrator platform for their internal and wider community use.



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## Chapter 1. Getting started with IBM Cloud Orchestrator content

IBM Cloud Orchestrator can be extended by providing different types of content packages to enable IBM Cloud Orchestrator to use the features that are delivered by external software and infrastructure devices.

The different types of IBM Cloud Orchestrator content that you can create and deploy in the cloud are explained here.

---

### Content packs

Content Packs provide the building blocks for orchestrations that run on the integrated Business Process Manager platform in IBM Cloud Orchestrator.

Content Packs typically consist of a set of process applications and toolkits. Process applications contain ready-to-use orchestrations and share library items from one or more toolkits. Toolkits typically contain building blocks to be used by process applications and other toolkits. They also provide sample processes and human services to demonstrate the usage of those building blocks.

IBM Cloud Orchestrator ships with a number of toolkits that provide building blocks that are related to pattern and image deployment, scripting support, and offerings. These building blocks can be used to create new toolkits or process applications. Refer to Chapter 4, “Developing toolkit and application content,” on page 7.

You can download extra content packs from the IBM Cloud Orchestrator Catalog.

Processes and human services that are contained in process applications or toolkits can then be configured to be run in IBM Cloud Orchestrator in the following way:

#### Self-service offerings

A self-service offering is a process that is not related to any pattern or instance. For example, add a user. To understand how to create a self-service operation, see the self-service offerings scenario. The offerings are grouped into categories.

For more information about self-service offerings, see the following topics:

- Designing self-service
- Using self-service
- Self-service offerings

---

### Virtual images

Virtual images provide the operating system and product binary files that are required to create a virtual system instance. Images can be extended to customize the virtual images and the operating systems by adding script packages that provide extra functions during provisioning time and software bundles that enhance the content of the image.

#### Software bundles

Software bundles contain and describe the software that is available for use within a virtual image. They include information about how to install the software, prerequisites of the software, and parameters that are available for customizing the software. They combine the operating system definition and custom software bundles to create virtual bundles that can be provisioned in the cloud.

---

## Chapter 2. IBM Cloud Orchestrator overview

IBM Cloud Orchestrator provides end-to-end service deployment across infrastructure and operating system layers. It provides integrated IT capabilities for orchestration workflow automation and IT governance, resource monitoring, and cost management.

Your data center policies, process, and infrastructure can be integrated with the cloud in a consistent, flexible, and automated way, across various IT domains. You can define and implement business rules and IT policies with an intuitive graphical tool. It helps you to connect the aspects of the different domains into a consistent orchestration of automated tasks and human tasks.

---

### Architecture

IBM Cloud Orchestrator is built on OpenStack and common pattern modeling. Business Process Manager provides workflow modeling and runtime capabilities. It is integrated so that event triggered automation provides the basis for cloud-centric workflow enablement. The contents, toolkits, and other building blocks can be found, used, adapted, and shared in the IBM Cloud Orchestrator Catalog. For more information about the IBM Cloud Orchestrator architecture, see Product architecture

#### **Cloud Provisioning and Orchestration Development Collaboration Community**

To evaluate future versions of this product, join the Development Collaboration Community. From the Cloud Provisioning and Orchestration Development Collaboration Community, you can use the hosted beta system and download the beta code. The hosted system has the latest evaluation code. If you want to evaluate in your own environment, download the beta code.

You can learn how to develop orchestration and other content in this community. To access the community, go to <https://www.ibm.com/developerworks/mydeveloperworks/groups/service/html/communityview?communityUuid=e5a54efe-3c9f-491b-af2a-e5400516b5aa>.



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## Chapter 3. Installing and configuring the IBM Process Designer

You must install and configure the IBM Process Designer, one of the user interfaces for Business Process Manager to start with IBM Cloud Orchestrator content authoring.

### Before you begin

This procedure describes the IBM Process Designer installation and configuration on a Windows operating system.

### Procedure

1. Install and configure IBM Cloud Orchestrator. See the *Installing* section of the IBM Cloud Orchestrator information center. Business Process Manager is installed as a product component.
2. Install IBM Process Designer on the Windows operating system on which you perform content development. See *Installing IBM Process Designer* in the Business Process Manager information center.
3. Configure IBM Process Designer to connect with Business Process Manager:
  - a. Edit C:\Windows\system32\drivers\etc\hosts.
  - b. On a new line, add the IP and host name (cs3-hostname) of the machine where the Business Process Manager is installed.
  - c. Save the file.
4. Start Process Designer to develop content.



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## Chapter 4. Developing toolkit and application content

You can develop toolkit and application content.

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### Implementing workflow orchestration

Workflow orchestration is a Business Process Manager based extension to IBM Cloud Orchestrator which consists of UI panels to collect extra data.

Workflow orchestration is optionally implemented by Business Process Manager human service and a Business Process Manager business process, which define the logical flow of activities of the extension. The extension itself consists of the human service and the business process, which are developed with the standard Business Process Manager designer. After development, it is registered as an extension operation in the Self-Service Offerings of IBM Cloud Orchestrator. After you register it, it is available in IBM Cloud Orchestrator.

The Business Process Manager-based extension type is:

#### Self-service offerings

A custom operation that is run in the context of the data center. These operations are administrative operations that are used to automate the configuration and user operations. Self-service offerings are used to enhance the catalog of available services with more features. They are classified into different categories. For more information about self-service offerings, see the following topics:

- Self-service offerings
- Designing self-service
- Using self-service

---

### Managing business processes

IBM Business Process Manager Standard is a comprehensive Business Process Management offering. It gives you visibility and insight to manage business processes. It offers tools and runtime environments for process design, execution, monitoring and optimization, and basic system-integration support.

The process application is the fundamental container for business processes and their components in Business Process Manager. It has a name and a unique tag (acronym) that can have a maximum length of 7 characters. Business Process Manager process applications and their related artifacts are stored within a repository, which is hosted and managed by the process center. Process applications can be created either from the web interface of the process center console or by using the Business Process Manager process designer tool.

**Important:** If you are a new user to Business Process Manager process designer, verify whether you are granted access to the process center repository. The access can be granted either by using the Business Process Manager process designer tools or the Business Process Manager process center console. If you are an administrator user, you can grant rights to other users:

1. Go to the **Admin** tab > **Manage Users**.
2. Click **Add Users/Groups**.

3. In **Add Users and Groups** dialog, enter the first few letters of the user as a search filter in the **Search for Name** panel.
4. Select the user and click **Add selected**.

The user is granted access to the Process Center repository and can use the Process Designer.

## Process application

A process application can contain one or more Business Process Definitions, which represent a model, or template, of a business process that is run. The process application consists of the following definitions and activities:

- Input and output variable definitions
- Business object data definitions
- User interface panel definitions
- Activities of the process that include the flow

The flow defines how the various activities of the process are orchestrated. When a process is started, an instance of the process is created from the process definition template.

## Toolkit

A toolkit is a container for Business Process Manager artifacts like Business Process Definitions, Business Objects, Human Services, Coaches, and Business Process Definitions. Toolkits are used to package reusable Business Process Manager artifacts as package content that can be used to build other Business Process Definitions. But in contrast to a Process Application, a toolkit cannot be deployed to the Business Process Manager runtime environment as a stand-alone solution. Instead, the artifacts that are contained can be used as building blocks by other Process Applications, but must be declared as a dependency on the toolkit. Multiple Process Applications can have a dependency on the same toolkit and toolkits can have also dependencies on each other. Toolkits and Process Applications can be exported as a .twx file. This file is transferred to other systems that run the Business Process Manager Process Center, or it is published to the IBM Cloud Orchestrator Catalog. You can download from the IBM Cloud Orchestrator Catalog and then import it into another Process Center. In IBM Cloud Orchestrator, do not use the option to export a toolkit or Process Application to a Business Process Modeling Notation (BPMN) file.

## Snapshot

The status of a Process Application or a toolkit can be captured by the Process Designer tool or the web console of the Process Center. This snapshot defines a specific version of the toolkit. It consists of all the related artifacts and their content or state at the time when the snapshot is taken. The tip level is the most recent version of a Process Application or toolkit. As a prerequisite, define a snapshot of a Process Application for most of the management actions like export Process application or toolkit, archive, define a dependency on a toolkit.

## Business Process Definition

A Business Process Definition is a reusable model of a process that defines what is common to all runtime instances of that process model. Processes are graphically modeled in the Process Designer tool, which captures the flow of steps (activities). This graphical diagram represents activities in the process as boxes and lines connect them to describe the flow of work. Each box represents an activity and is labeled with its description in the diagram. A Business Process Definition must contain a start event, an end event, at least one lane, and one or more activities. Lanes are used to segment the drawing canvas of a Business Process Definition into one or more horizontal sections. For example, when an activity (Business Process Manager artifact) is added to the process diagram, its vertical position determines the lane to which it belongs. Because each lane can be associated with a role, you can observe the association of an activity of a Business Process with the role. For each Business Process Definition that you create, you must declare variables to capture the business data that is passed from activity to activity in your process. Variables can be input to the process (input variables), output from a completed process (output variables), or local variable (private variables).

### Related information:

 [http://www.ibm.com/support/knowledgecenter/SSFPJS\\_8.0.1/com.ibm.wbpm.main.doc/topics/cbpm\\_bpd.html](http://www.ibm.com/support/knowledgecenter/SSFPJS_8.0.1/com.ibm.wbpm.main.doc/topics/cbpm_bpd.html)

## Service

The activities that are contained in the Business Process Definition describe the overall flow of the process, but it does not capture the implementation of the process. Services are reusable implementations of activities in a Business Process Definition. When a Business Process Definition starts, the services carry out the required functions.

The following types of services are available in Business Process Manager:

### Integration service

Use an integration service when you want to integrate with an external system. An integration service is the only type of service that can contain a Java or web service or REST integration.

### General system service

Use a general system service when you must coordinate other nested services or when you must manipulate variable data. General System services cannot include Java, web service, or REST integrations directly.

### Human service

Use a human Service when you want an interactive service with UI panels (Coaches). Human Services generate human tasks in the Business Process Manager Process Portal.

### Ajax service

Use an Ajax service when you want to include a control in a Coach to implement dynamic data selection. For example, you can automatically populate lists and complete edit boxes. An Ajax service can pull data dynamically from a connected data source such as a database.

### Decision service

Use a decision service when you want a condition to determine the implementation.

### Web service

Use a web service to implement a web service in Business Process Manager.

### Related information:

[http://www.ibm.com/support/knowledgecenter/SSFPJS\\_8.0.1/com.ibm.wbpm.wle.editor.doc/modeling/topic/creating\\_services\\_B.html](http://www.ibm.com/support/knowledgecenter/SSFPJS_8.0.1/com.ibm.wbpm.wle.editor.doc/modeling/topic/creating_services_B.html)

## Participant group

A participant group is used to represent a set of users in your organization or enterprise locally within an application. Participant groups can be found in the Processes category within Business Process Manager Process Designer. The members of a Participant Group are local to the Business Process Application in which it is defined. In contrast, the Security Groups provide a global mechanism to define groups.

**Remember:** A participant group is a logical group that does not exist outside of the concept of the Business Process Application in which it is defined. After a Business Process Application is installed on a Process Server in a different environment, you must add or remove users in those groups. For this management, use the Business Process Manager Process Admin Console.

## Coach validation framework

Business Process Manager includes a server-side validation framework for validating coach data that is entered during run time. This feature simplifies the validation logic that identifies invalid user input and sends notifications during run time. Server script or a service defines the validation logic. Any service, other than Ajax service or a human service can be used as a validation service. Multiple coaches in a human service flow can use the same validation service or server script. The `coachValidation` of type `CoachValidation` business object is a new system variable that contains information about validation errors.

### Fire validation

The fire validation when added to a link connects a boundary event to the next step to indicate whether the validation must be started for this boundary event.

In a human service diagram, go to the **Properties > Behavior** of a coach. Select **Before** or **Never** in the **Fire Validation** field. On selection of **Before**, the validation is done before moving to the next step.

### Stay on page

The Stay On Page event in a human service flow causes the flow to return to the originating coach. For example, if there is a validation error in the input, the focus is returned to the originating coach to correct the input.

### Server script to define validation

Specify validation logic in the **Properties > Implementation** for the server script. Add the error data to the system variable `coachValidation` by using an API. For example, `tw.system.addCoachValidationError`.

It takes three parameters. The first parameter is the system variable `coachValidation`. The second parameter is a string that contains full path to the

data item that contains the error. The third parameter is the message that must be displayed when there is an error. If the invalid data is not bound to any coach view, then the validation error is not displayed.

---

## Implementing extensions with IBM Cloud Orchestrator

You can build custom extension operations that are based on business processes and human services, for UI extensions, by using the Business Process Manager Process Designer tool. The business logic of the extension is implemented by the Business Process Definition. The association between a UI extension that is based on a human service and business process definition is done during the registration of the extension operation in the instance actions or self-service offerings.

IBM Cloud Orchestrator delivers a Business Process Manager toolkit that is called **SCOrchestrator\_Toolkit**. It provides many useful artifacts such as business processes, services, human services, coaches, business object definitions, java classes that assist you to build custom extensions operations for IBM Cloud Orchestrator. Additionally, the `SCOrchestrator_Toolkit` contains samples that show how to build custom extensions. Other Business Process Manager toolkits are downloadable from the IBM Cloud Orchestrator Catalog. They provide extra content for different areas (networking, storage) that can be used to build IBM Cloud Orchestrator extensions.

**Restriction:** If a process application or a toolkit in Business Process Manager has more than one defined snapshot, then only the artifacts at the top level can be used to define a new extension in the instance actions or self-service offerings. The artifacts below the tip level are not considered.

## Implementing a custom operation for IBM Cloud Orchestrator

The following steps are needed to develop a custom extension operation with or without a user interface for IBM Cloud Orchestrator:

### Before you begin

Make sure that the `SCOrchestrator_Toolkit` is imported into the Business Process Manager Process Center repository. Refer to [http://www.ibm.com/support/knowledgecenter/SSFPJS\\_8.0.0/com.ibm.wbpm.admin.doc/managinglib/topic/managing\\_toolkits\\_I.html](http://www.ibm.com/support/knowledgecenter/SSFPJS_8.0.0/com.ibm.wbpm.admin.doc/managinglib/topic/managing_toolkits_I.html).

### Procedure

1. Create a Business Process Manager Process Application as a container for your extension operation. For information about managing process applications, refer to [http://www.ibm.com/support/knowledgecenter/SSFPJS\\_8.0.0/com.ibm.wbpm.admin.doc/managinglib/topic/managing\\_process\\_applications\\_A.html](http://www.ibm.com/support/knowledgecenter/SSFPJS_8.0.0/com.ibm.wbpm.admin.doc/managinglib/topic/managing_process_applications_A.html).
2. In the Business Process Manager Process Designer, open your Business Process Application and declare a dependency on the `SCOrchestrator_Toolkit`.

**Note:** The toolkit contains useful building blocks for writing extensions.

3. In the toolkits category, click + and add the dependency to the `SCOrchestrator_Toolkit`.
4. In the same manner, import and add dependencies to other toolkits as needed.
5. Create business process definitions and human services (extensions) for IBM Cloud Orchestrator.

**Note:** You can use the building blocks available in the SCOrchestrator\_Toolkit. To use a building block that is provided by a toolkit, do the following tasks:

- Drag the corresponding building block from the toolkit to the process or service canvas in the Process Designer.
  - Connect it with the other steps or activities of the business process or service.
  - Map the input and output variables of the building block to the variables of the embedding business process or service.
6. Create a snapshot of your business process application. For information about the steps, see [http://www.ibm.com/support/knowledgecenter/SSFPJS\\_8.0.0/com.ibm.wbpm.admin.doc/managinglib/topic/managing\\_snapshots\\_A.html](http://www.ibm.com/support/knowledgecenter/SSFPJS_8.0.0/com.ibm.wbpm.admin.doc/managinglib/topic/managing_snapshots_A.html)
  7. Register the extension operation in the IBM Cloud Orchestrator UI. For more information about custom operation registration, see Designing self-service.

## Results

You can now use the extension operation in IBM Cloud Orchestrator.

### Related tasks:

Chapter 8, “Publishing IBM Cloud Orchestrator content to IBM Cloud Orchestrator Catalog,” on page 29

IBM Cloud Orchestrator Catalog is a platform and one-stop-shop for IBM Cloud Orchestrator customers, partners, and IBM employees. The content that you create can be submitted internally or externally from IBM in Integrated Service Management Library (ISML) for Cloud/Virtualization category. The primary goal is to have an environment where developers, partners, and IBM Service teams share content with one another. This web-based application is envisaged to federate content from several repositories into a single cloud automation content catalog.

## Start a custom extension operation

Starting a custom extension operation is done with or without a user interface. Start the operation and the following activities are automatically run in the specified sequence:

1. During the following conditions, a task with an operation context is created in the task engine with the status as 'New':
  - A self-service offering or user action is triggered from within the IBM Cloud Orchestrator UI.
2. If a human service is not registered in the instance actions or self-service offerings for this operation, then this step is skipped.
  - Human service starts with the coach UI panels.
  - It is passed to the operation context ID (task ID) as parameter.
  - The first activity of the human service is to run a REST call against IBM Cloud Orchestrator to get the operation context business object. It is based on the operation context ID that is given as input parameter.
  - The coach gathers the parameters from the user and store the parameters into the output business object of the human service.
  - When all user input information is collected, the last activity in the Business Process Manager human service (ReturnParameters) is run to persist the output business object into the operation context of the task engine. These business objects can be used later by the extension Business Process Manager Business Process. The status of the task in the task engine is set 'Queued' so that the task can continue to run.

3. The task engine starts the Business Process Manager process, which gets the operation context as input parameter. For self-service offering and instance actions, the process starts directly after the human service ends. The Business Process Manager process defines an input business object, which contains the parameters that are collected by the user interface of the related human service. The parameter section of the operation context also contains the parameters that are collected by the graphical user interface of the human service.

## Using instance data provided by OperationContext

To support the orchestration development, IBM Cloud Orchestrator provides an OperationContext object containing useful information. When using instance actions, the OperationContext object contains information about the instances on which the operation is executed.

There are two types of instance actions: instance actions that are executed on a single instance, and instance actions that are executed on multiple instances (for example, when multiple instances are selected in the resource view).

For instance actions, as part of the OperationContext object, one or multiple instance IDs are passed to the Business Process Manager human service and process. They can be found in OC.parm.instances.

An instance ID has the following format:

```
https://<ico_server>/orchestrator/v2/instancetypes/<type>/instances/<providerInstanceId>
```

where <providerInstanceId> is resource type specific:

- For OpenStack Nova: <region>--<openstackid>
- For OpenStack Heat: <region>--<stackname>--<openstackid>
- For Azure cloud service: <region>--<servicename>
- For Azure deployment: <region>--<servicename>--<deploymentname>--<slot>

The following integration services are provided to extract the IDs and update the instances parameter:

- “GetInstanceIdFromOperationContext” on page 38
- “GetMultipleInstanceIdsFromOperationContext” on page 38
- “UpdateInstancesParmInOperationContext” on page 40

## Implementation of a human service as a UI extension

A Business Process Manager human service that can be used as UI extension for IBM Cloud Orchestrator is developed with Business Process Manager Process Designer. Observe the following guidelines:

- Make the human service available in Business Process Manager as URL to the participant group, which is used in IBM Cloud Orchestrator. This activity can be done in the Process Designer as follows:
  1. Go to the **Overview** tab of the design view.
  2. In the Exposing section, select **All Users** in **Expose to Start**.
  3. Register the process in the instance actions or self-service offerings:
    - a. In the IBM Cloud Orchestrator UI, go to **CONFIGURATION > Self-Service Catalog**.
    - b. Create a registry entry for the process you created.
    - c. You can request the new service from self-service offerings with the UI.

The participant group controls the visibility of the extension operation in the instance actions or self-service offerings for the user or user group. It decides which users or user groups are allowed to run the extension.

- The business object defines the interface of the human service and the related business process. This business object contains the parameters to be returned by the human service. The human service acts as an UI extension for IBM Cloud Orchestrator, which are the input parameters of the related business process. Therefore, a human service defines an output variable with name `outputParameterObject`. It is of type business object that is defined by the creator of the extension.
- Declare operation context ID as an input variable of type string. The human service gets the operation context ID as input variable. For example, `operationContextId`. As first activity of the human service (before it can access the operation context), it must use the activity `GetOperationContext` that is delivered with the `SCOrchestrator_Toolkit`. This activity retrieves the operation context by using the operation context ID.
- Define a UI coach or a sequence of coaches to collect the data that is needed from the user.
- As a last activity, the human service calls the `ReturnParameters` integration service of `SCOrchestrator_Toolkit`. Here, the data that is collected from the user is registered on the `operationContext`. This data is then passed as an input parameter to the associated business process.

**Related concepts:**

“Coach validation framework” on page 10  
Coach validation framework

---

## Implementation a Business Process Manager process as an extension

A business process that can be used as extension operation for IBM Cloud Orchestrator is developed by using Process Designer. It must observe the following guidelines:

- The Process Designer must be made available in the Business Process Manager as URL to the participant group. This group uses it in IBM Cloud Orchestrator. The participant group controls the user or user group visibility for the extension operation. It is made visible in the configurations to be registered as extension operation. It also decides which users or user groups are allowed to run the extension.
- Every Business Process has `inputParameterObject`, which is an input parameter. The type of this variable is same as the output parameter of the associated human service. The first activity of the Business Process is `GetInputParameter` (part of `SCOrchestrator_Toolkit`), which populates the `inputParameterObject`.
- The business process gets the operation context object as an input parameter and must define a corresponding input variable of type `OperationContext`. It is a predefined business object definition that is delivered by `SCOrchestrator_Toolkit`.
- With activities, the business process can access the information that is contained in the operation context. Also, the information is handed over as parameter from the associated human service. It can also use REST calls to retrieve further information from IBM Cloud Orchestrator. REST calls are implementations that are provided by `SCOrchestrator_Toolkit`.

---

## Best practices and guidelines

When you create toolkits or Process Applications, there are some best practices to be followed in naming conventions, structuring, modeling, and error handling.

### Guidelines for naming and documenting your toolkit or process application

When you create toolkits, use the following naming conventions:

- Name the toolkit after the utility or services it provides.
- Add words like "Toolkit" or "Framework" so that you can differentiate it from other process applications.
- Avoid long names. You must use fewer than 64 characters.
- White spaces between words can be added if it improves readability.
- Avoid the version number in the name, unless you want to bring attention to the major changes in the solution.
- Add more information about the toolkit in **Description** field.
- Choose an acronym for your toolkit. Do not use the prefix "IC" as it is used for content that is delivered by IBM.
- Name your snapshots according to this scheme: AABB\_YYYYMMDD. Exported TWX archives of your toolkit get this snapshot name appended, so you can easily identify the exported snapshots later.

**AA** The IBM Cloud Orchestrator release that is prerequisite for the toolkit or process application, for example, 25 for IBM Cloud Orchestrator V2.5.

**BB** Counting up the version of the toolkit, for example. 00 for the first release, and 01 for the second release

#### YYYYMMDD

The date the snapshot was created

- When updating an existing process application or toolkit, do not change the chosen acronym because it is used to reference the processes in self-service offerings.

### Guidelines for creating artifacts in a toolkit

The general best practices are as follows:

- In the documentation field for a Business Process Manager artifact, enter a description of the input and output parameters of that artifact.
- Use the note object of Business Process Manager to improve the readability of complex processes and human services.
- As mentioned in the naming conventions, provide an understandable and meaningful name for your artifacts.
- Keep the interface definition between a Business Process Manager Human Service and its associated Business Process Manager Business Process Definition as short as possible. The interface is defined by a Business Process Manager Business Object. This object is used to correlate a business process with its associated human services in the IBM Cloud Orchestrator Self-service user interface. Use the Business Process Manager human service only to collect the parameters that are needed by its associated business process. Implement the business logic in the business process. It also helps if you enable the business process to be called by using the REST API from an external application, such as a portal application.

- Avoid **Pre** and **Post** execution assignments. Instead, add explicit activities, if needed. The execution assignments are hidden in the Business Process Manager Process Designer, and the logic of the corresponding activity or service becomes difficult to understand. If needed, use the **Pre** and **Post** executions to make simple assignments like initializing the associated Business Process Manager artifact. For example, consider having two consecutive coaches in a human service. In such cases, do not initialize the objects that are used by the second coach as being **Post** execution assignment of the first coach. If needed, do the initialization as a preexecution assignment of the second coach.
- Do not use passwords in environment variables or other artifacts that are visible to everyone.
- When you deliver a solution for IBM Cloud Orchestrator, make sure that there are no validation errors. These errors can be seen in the Process Designer.
- Avoid changing the interface of a building block that is delivered as a part of a toolkit. If you change the interface of building blocks in a toolkit, it becomes cumbersome for all its dependent toolkits or Process Applications. Even changing the name might lead to redoing the mapping for all activities or services that use the building block.

### Guidelines to structure your solution

- In general, an extension content solution for IBM Cloud Orchestrator consists of a Business Process Manager Process Application and a Business Process Manager Toolkit.

The basic rule is that a process application contains artifacts that are ready to be used by the user and not meant to be changed or adapted to be useful. All other artifacts are better placed in a toolkit.

- When structuring your solution, always consider the visibility of your artifacts. Artifacts of one process application are not visible by default to another process application.

For example, a Business Process Manager, process A, can be called by another Business Process Manager, process B. The 'Linked Process' activity is used if both are in the same process application or if process A is in a dependant toolkit.

Avoid cyclic dependencies, that is, when toolkit A depends on toolkit B, avoid having a dependency on toolkit A. If such a cyclic dependency occurs, restructure your toolkits to resolve it.

- Use Business Process Manager tags and smart folders to structure your solution to make it more understandable. If you have UI parts that can be used in UI panels, define them as Coach views. These views can be reused in different Coaches. If you must change something later, for example, wording, you change only the reusable Coach view.

### Guidelines for handling errors

An IBM developerWorks article explains extensively about exception handling and logging from a business process management perspective. See Related Links. It identifies the types of exceptions that are encountered in a Business Process Manager scenario. Also, it shows you how to handle them using IBM Business Process Manager.

The following are best practices in error handling:

- Use the PostMessage integration service that is delivered as a part of the SCOrchestrator\_Toolkit to report messages that occur in Business Process Manager processes or Human Services back to the IBM Cloud Orchestrator

Self-service user interface. For event and instance operations, these messages are written to the history section of the pattern instance. For self-service offerings, these messages are written to the operationContext and are displayed in the UI.

- Define error message as localization resources.
- Raise errors in your integration services or processes by using the Error End Event node.
- Catch raised errors that are raised from integration services by using Intermediate Error Events or Event Subprocesses.
- For Java classes that are used in Business Process Manager processes or human services, define logging framework. For example, `java.util.logging` to log messages to the WebSphere log.
- Use the logging capabilities of Business Process Manager to log messages to the WebSphere log. A good practice is to log in the entry and exit of an activity to support debugging better.

**Related information:**

 <http://www.scribd.com/doc/92505753/IBM-Impact-2011-Five-Guidelines-to-Better-Process-Modeling-for-Execution-Stuart-and-Zahn>

You can find many documents with guidelines and best practices about business process modeling. One of it is *Five Guidelines to Better Business Process Modeling for Execution* from Jonas A. Zahn and Stuart Jones, which describes the following design guidelines:

- Rule of Seven - limit any view to no more than seven steps for a good fit.
- Activity granularity - activities must be similar in scope at each level. Avoid the String of Pearls pattern, that is, series of activities in the same lane.
- Activity description - use [action verb] + [business object] and avoid vague verbs like 'process' and 'perform'.

 [http://www.ibm.com/developerworks/websphere/library/techarticles/1105\\_ragava/1105\\_ragava.html](http://www.ibm.com/developerworks/websphere/library/techarticles/1105_ragava/1105_ragava.html)

---

## Importing and exporting toolkits and process applications

You can create toolkits or reuse toolkits that are shared by other content developers. To use a toolkit that is created and shared by other content providers, use the import toolkit feature. You can use export and import utilities to move the toolkit from development process server to production process server or between any two process servers.

### Importing toolkits

#### Before you begin

To import toolkits into the Business Process Manager, complete the following steps:

#### Procedure

1. In the **Business Process Manager Designer**, click **Process Center**.
2. In **Toolkits**, click **Import Toolkit**.
3. In **Import Toolkit**, click **Browse** to select the file to import.

**Tip:** The Toolkit file extension is in `twx` extension format.

4. Click **Ok**.

**Related information:**

## Exporting toolkits

To export to a Business Process Manager export file, complete the following steps:

### Procedure

1. Select the **Toolkits** tab.
2. Click the toolkit that you want to export from the list of toolkits.
3. Find the snapshot that you want to export.
4. If a snapshot does not exist, click **Create New Snapshot**.
5. Click the **Export** option for the snapshot.
6. Select BPMN export (.zip) or IBM BPM export (.twx) and click **Export**.
7. Locate the directory to which you want to save the exported file.
8. Name and save the file. The exported file can be imported into any Process Center repository.

---

## Business Process Manager security

For a class of use cases, it is important to understand the security context of a Business Process Manager process or user interface. The activity-based user authentication and authorization are described here.

Business Process Manager user interfaces are run as the currently logged in user and project. They are used as the initial dialog for collecting data in self-service offerings and in instance actions. They are also used for assignments in the My Inbox panel. Retrieve the currently logged in user with this JavaScript (R) expression in Business Process Manager: `tw.system.user_loginName`.

Activities in the system lane of a business process are run in the background. Therefore, there is no currently logged in user. By default, activities are run as an admin user and project. The admin user is `tw_admin` in Business Process Manager.

Additionally, there are use cases where it is important to know which user, domain, and project submitted a self-service offering or orchestration action. This information is found in the variables `user`, `domain`, and `project` of the operation context.

For instance, the `GenericRESTCall` integration service of the `SCOrchestrator_Toolkit` extracts the authentication information from the security context by default. The service then uses the extracted information to construct the security authentication token (simple token) for REST calls to external systems. Because the `tw_admin` is an internal user, `GenericRESTCall` translates `tw_admin` to the default admin user (generally `admin`) for external calls. It is desirable to run these REST calls on behalf of the person who submitted the request. To do that, map the `user`, `domain`, and `project` variables from the operation context to the `GenericRESTCall`.

---

## Chapter 5. Importing by using the command-line interface

You can import IBM Cloud Orchestrator content using the command-line interface.

The following tool supports the import of content by using command-line interfaces:

- “Import content pack into Business Process Manager”

**Important:** You must have a command shell to run these commands.

### Import content pack into Business Process Manager

A Business Process Manager-based extension to IBM Cloud Orchestrator consists of UI panels to collect more data. To import a content pack in to a Business Process Manager, start the command-line interface in interactive mode and then run the import command.

To start the command-line interface in interactive mode, use this syntax -  
`wsadmin.sh -h <hostname> -user <username> -password <password> -lang jython`. To Import content pack, use this syntax - `>>>AdminTask.BPMImport('[-inputFile <file path>]')`.

The `wsadmin.sh` is in the Business Process Manager server installation directory and its parameters are as follows:

**-h <host> or --host**

Specifies the host name or IP address of the Business Process Manager. This parameter is required.

**-user**

Specifies the user ID to authenticate to the Business Process Manager. Use the same user ID and password that you use to log on to the tool. This parameter is optional.

**--password**

Specifies the password that is used to authenticate to the user. This parameter is optional and is case-sensitive.

```
wsadmin.sh -user admin -password admin -lang jython
wsadmin>AdminTask.BPMImport('[-inputFile /tmp/abc.twx]')
```

For more information about Business Process Manager command-line interface, see [http://www.ibm.com/support/knowledgecenter/SSFPJS\\_8.5.0/com.ibm.wbpm.ref.doc/topics/rref\\_bpmimport.html](http://www.ibm.com/support/knowledgecenter/SSFPJS_8.5.0/com.ibm.wbpm.ref.doc/topics/rref_bpmimport.html).



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## Chapter 6. Example scenarios for workflow-based orchestration

Workflows are driven by the following self-service offering trigger.

A quick start guide is available in the IBM Cloud Orchestrator Catalog for content development. Search for this guide in the IBM Cloud Orchestrator Catalog by using the search filter `SCOrchestrator Content QuickStart Guide`. For more information about searching and downloading from the IBM Cloud Orchestrator Catalog, see Chapter 8, “Publishing IBM Cloud Orchestrator content to IBM Cloud Orchestrator Catalog,” on page 29.

---

### Self-service offerings scenario

Self-service offerings are custom operations that can be run in the context of the data center. Such offerings can be used to automate configuration tasks or to enhance the catalog of the available services with extra features. This scenario depicts a self-service offering for registering the firewall host device on IBM Cloud Orchestrator by storing the firewall details in the storehouse.

#### Procedure

1. In the Process Designer, click **Create a New ProcessApp** or **Toolkit** and name it `RegisterFirewall`.
2. Open the `RegisterFirewall` application or toolkit in the Process Designer.
3. Create a dependency on the `SCO_Orchestrator_Toolkit` and the `SCOrchestrator_Scripting_Uilities_Toolkit`.
  - a. Click the plus sign (+) to the right of **Toolkit**.
  - b. From the **Add dependency** dialog, select `SCO_Orchestrator_Toolkit`.
  - c. Select the latest snapshot.
  - d. Repeat the procedure for `SCOrchestrator_Scripting_Uilities_Toolkit`.
4. Create a human service.
  - a. Click the plus sign (+) to the right of **User Interface**.
  - b. Add new human service and name it `Register_Firewall_Host_HS`. This human service includes a coach that collects the required input.
  - c. Click the **Variables** tab.

Table 1. Input Variables

Variable	Type	Description
operationContextId	String	The ID contains the operation context object identifier, and it is passed during the start of the operation by the IBM Cloud Orchestrator framework. The identifier is used to fetch the operationContext, which is an object that contains all the data that is related to the execution of an operation. <b>Note:</b> This variable is mandatory for all human services that are run through IBM Cloud Orchestrator.
outputParameterObject	FirewallHost	The output parameter is of type FirewallHost business object that has register firewall host-related parameters such as host IP address, user name, and password.

Table 2. Default values of outputParameterObject

Property	Value
hostIpAddress	" "
username	"root"
password	" "
commandLine	"iptables -I INPUT -p tcp --dport 80 -j ACCEPT; service iptables save "

- d. Create a business object and name it FirewallHost. Add the following parameters to this business object:

Table 3. Output Variables

Variable	Description
hostIpAddress	IP address of the firewall host.
username	Log in user on the firewall host.
password	Password for the user on the firewall host.
commandLine	Command line to configure firewall.

- e. Create the following coaches:

Table 4. Coach

Coach	Input fields
firewall_host_coach	hostIpAddress
	username
	password
	commandLine

- Map the parameters from the outputParameterObject to these coach fields.
- f. Use the ReturnParameters integration service from the SCOrchestrator\_Toolkit before the 'end' activity.
    - 1) Click SCOrchestrator\_Toolkit to expand it.
    - 2) Click **Implementation**.
    - 3) Drag and drop the **ReturnParameters** integration service.
  - g. Map the operationContextId and outputParamaterObject variable as an input to this service.
    - 1) Click **ReturnParameters**.
    - 2) Click **local.input**.
    - 3) Map local.input.operationContextId to operationContextId, Local.Input.outputParamaterObject to outputParamaterObject.
  - h. Connect the activities to complete the human service.
5. Create a **Business Process Definition**.
- a. Click the plus sign (+) to the right of **Processes**.
  - b. Create a **Business Process Definition** and name it as Register\_Firewall\_Host\_BPD.
  - c. Click **Variables** tab
  - d. Click **Add Input** and create the following input variables:

Table 5. Input Variables

Variable	Type	Description
operationContext	OperationContext	The operationContext object contains all the data that is related to the execution of an operation.
inputParameterObject	FirewallHost	The input parameter is of type FirewallHost.

**Note:** Both the input variables are mandatory for all business processes that are run from IBM Cloud Orchestrator.

- e. Add the integration service GetInputParameter from SCOrchestrator\_Toolkit as first activity in the business process. Complete the data-mapping for this service:
 

Input Mapping:  
 tw.local.operationContext -> operationContext  
 tw.local.inputParameterObject -> inputParameterObject\_in

Output Mapping:  
 inputParameterObject -> tw.local.inputParameterObject
  - f. Add the integration service SSH\_ExecuteCommand from SCOrchestrator\_Scripting\_Utilities\_Toolkit. Complete the data-mapping for this service:
 

Input Map:  
 tw.local.inputParameterObject.hostIpAddress -> remoteMachine  
 tw.local.inputParameterObject.username -> username  
 tw.local.inputParameterObject.password -> password  
 tw.local.inputParameterObject.comandLine -> commandLine
  - g. Connect the activities to complete the business process.
6. Expose the human service to the participant group.
- a. Go to the **Overview** tab of the human service.
  - b. Select all users for **Exposed to** for the option under **Exposing**.

- c. Select **Expose as URL (Available from a URL)**.
7. Expose the business process to the participant group.
  - a. Go to **Overview** tab for the business process.
  - b. Select all users for **Expose to Start** to start option under **Exposing**.
8. Register the operation in the IBM Cloud Orchestrator UI.
  - a. Log in to the IBM Cloud Orchestrator UI.
  - b. Click **CONFIGURATION > Self-Service Catalog**.
  - c. Click **Offerings** and then click **Create Offering** in the **Actions** menu.
  - d. Enter the following details:
    - **Offerings name** - enter the name of the new offering.
    - **Description** - enter the description.
    - **Offering icon** - select the icon from the list.
    - **Process** - select the Register\_Firewall\_Host\_BPD from the list. It is the Business Process Definition that is created in the Process Designer.
    - **User Interface** - select Register\_Firewall\_Host\_HS. The human service is created in the Business Process Designer.
  - e. Click **Create**.
9. Run the Self-Service Offering.
  - a. Go to **Self-Service**.
  - b. Click **Category**.
  - c. Click **Offering**.
  - d. Enter the details and click **OK**.
10. After the operation completes successfully, check that the firewall setting command is run on the host.

**Related information:**

 [http://www.ibm.com/support/knowledgecenter/SSFPJS\\_7.5.0/com.ibm.wbpm.main.doc/managinglib/topic/managing\\_toolkits.html](http://www.ibm.com/support/knowledgecenter/SSFPJS_7.5.0/com.ibm.wbpm.main.doc/managinglib/topic/managing_toolkits.html)  
Information about how to include integration service, process, coach, and human service inside the toolkit library.

---

## Chapter 7. Automating the creation of categories, offerings, and instance actions

You can automate the creation of categories, offerings, and instance actions by using the `catalogTool.sh` tool.

### Before you begin

The `catalogTool.sh` tool is installed together with IBM Cloud Orchestrator. The installation directory of the tool is `/opt/ibm/ico/ccs/catalog`.

The tool selects the JVM in the following order:

1. The JVM used by the Business Process Manager, if it exists
2. The JVM defined in `PATH` variable, if there is any
3. The JVM in the `JAVA_HOME` variable, if it has been defined

The `catalogTool.sh` tool is installed on the Business Process Manager node.

To automate the creation of categories, offerings, and instance actions, you need the following items:

- A configuration file that describes the IBM Cloud Orchestrator environment
- An XML file that represents the resources to be created
- Valid credentials to connect to the IBM Cloud Orchestrator. Admin role is required.

**Note:** Although, in this topic, the script is `catalogTool.sh`, if you are installing on a Windows operating system, the script is `catalogTool.bat`.

### About this task

The following directories contain the following items:

#### **conf**

- `log4j.properties`, logs, and trace configuration
- `env.properties`, the configuration file for IBM Cloud Orchestrator (IP address)

#### **samples**

Various XML files that can be used as examples

**lib** Resources that are required by the script

**logs** Log files

To compile your own XML file, start from one of the provided samples and create your `<category>`, `<offering>`, `<instance-type>`, and `<instance-action>` elements.

For a **category**, specify the name, for example:

```
<category>
  <name>A test category</name>
  <description>An optional description</description>
  <icon>Web</icon>
</category>
```

The description and icon fields are optional. For icon, the following values are allowed:

**Cloud** Cloud Category Icon

**Application**

Application Category Icon

**Backup**

Backup Category Icon

**Client** Client Category Icon

**Configuration**

Configuration Category Icon

**Job** Job Category Icon

**Network**

Network Category Icon

**Server** Server Category Icon

**Storage**

Storage Category Icon

**Virtual Machine**

Virtual Machine Category Icon

**Web** Web Category Icon

For **offerings**, specify the following parameters:

```
<offering>
  <name>A test offering</name>
  <description>An optional description</description>
  <icon>Web</icon>
  <category-name>Reference a category by name here</category-name>
  <process toolkit-name="toolkit_name">
    <name>Enter the name of the process you want to link to the offering</name>
  </process>
  <user-interface toolkit-name="toolkit_name">
    <name>Enter the name of the user interface you want to link to the process</name>
  </user-interface>
</offering>
```

You can use the same labels that are displayed in the UI when creating a new self-service offering. The description and icon fields are optional. For icon, the same fields that are described for category are allowed here too.

The attribute **toolkit-name** for the <process> and <user-interface> elements is optional and can be specified to state which toolkit contains the process/user-interface.

For **instance actions**, specify the following parameters:

```
<instance-action selection-type="multiple">
  <name>An instance action</name>
  <description>An optional description</description>
  <icon>Icon</icon>
  <instance-type>Resource type to which you can apply the action</instance-type>
  <process toolkit-name="toolkit_name">
  <user-interface toolkit-name="toolkit_name">
    <name>Enter the name of the process you want to link to the useraction</name>
  </user-interface>
  </process>
  <tags>You can mark the instance with an unlimited amount of tags to filter actions.
```

```

    <tag>Any_tagA</tag>
    <tag>Any_tagB</tag>
  </tags>
</instance-action>

```

The selection-type field can have a value of either "multiple" or "single" depending on if the action is applicable to only one instance or to several instances. The default is "single."

For **instance type**, specify the following parameters:

```

<instance-type>
  <name>A_unique_instance_type_name</name>
  <Display name>The name as it appears in the UI</description>
  <icon>Icon</icon>
  <Provider>The provider</instance-type>
  <details-view>
    <toolkit-name>Toolkit_Name</toolkit-name>
    <user-interface>UI display view of type of resource</user-interface>
  </details-view>
  <keyfields>
    <keyfield>
      <attribute>Instance type attribute</attribute>
      <header>Header of the column that displays the corresponding attribute in the resource list
    </keyfield>
  </keyfields>
  <tags>You can mark the instance with an unlimited amount of tags to filter actions.
    <tag>Any_tagA</tag>
    <tag>Any_tagB</tag>
  </tags>
</instance-type>

```

Keyfields are column headers in the UI. Detail-view is the details view panel of the UI.

**Note:** If you want to import XML files that are related to version 2.4 toolkits, ensure that your XML has the version attribute set to 2.4 in the catalog tag, for example `<catalog version="2.4">`.

The overall structure of the XML file is:

```

<catalog>
  <automation-categories>
    your categories here
  </automation-categories>

  <offerings>
    your offerings here
  </offerings>

  <instance-types>
    your instance types here
  </instance-types>

  <instance-actions>
    your instance actions here
  </instance-actions>
</catalog>

```

To create the resources that are described in `<yourfile>.xml` in the IBM Cloud Orchestrator Self-Service catalog, run the following command:

```
./catalogTool.sh <yourfile>.xml <IC0 username> <IC0 username password>
```

where

- <yourfile>.xml is your catalog file to create your catalog resources
- <ICO username> in a IBM Cloud Orchestrator administrative user name
- <ICO username password> is the password for the user who is specified previously

**Note:** Being an administrative tool, the tool must not be run in concurrent mode. You cannot run an instance of the tool and catalog administration from the IBM Cloud Orchestrator.

## What to do next

**Note:** The catalog version must NOT be set for version 2.3 XML files.

An extra step is required if the tool is installed as separate component from IBM Cloud Orchestrator, for example, the tool is purchased and downloaded from IBM Cloud Orchestrator Catalog and installed on a desktop. You must edit the tool configuration file, which is at `conf/env.properties`, with the following content:

```
IWD_HOST = <IP or HOSTNAME of Cloud Orchestrator>
IWD_PROTOCOL = https
IWD_PORT = 8443
```

`IWD_PROTOCOL = https` and `IWD_PORT = 8443` are the default values that you must use.

---

## Exporting by using the `catalogTool.sh` tool

You can export all offerings, categories, instance types, and instance actions to XML using the `catalogTool.sh` tool.

### About this task

Use the following commands to export:

```
./catalogTool.sh --export <xmlfile> <ico-user> <ico-password>
    To export everything.
```

```
./catalogTool.sh --export <xmlfile> <ico-user> <ico-password>
--includeCategories=<category_1>,<category_2>
--includeInstanceTypes=<instanceType_1>,<instanceType_2>
    Exports all the indicated categories and related offerings. Exports the
    instance types and the related instance actions.
```

```
./catalogTool.sh --export <xmlfile> <ico-user> <ico-password>
--excludeCategories=<category_1>,<category_2>
--excludeInstanceTypes=<instanceType_1>,<instanceType_2>
    Exports everything except the indicated categories and related offerings.
    Exports everything except the instance types and the related instance
    actions.
```

`--includeCategories` and `--includeInstanceTypes` can be used either together or alone. The same applies to `--excludeCategories` and `--excludeInstanceTypes`.

---

## Chapter 8. Publishing IBM Cloud Orchestrator content to IBM Cloud Orchestrator Catalog

IBM Cloud Orchestrator Catalog is a platform and one-stop-shop for IBM Cloud Orchestrator customers, partners, and IBM employees. The content that you create can be submitted internally or externally from IBM in Integrated Service Management Library (ISML) for Cloud/Virtualization category. The primary goal is to have an environment where developers, partners, and IBM Service teams share content with one another. This web-based application is envisaged to federate content from several repositories into a single cloud automation content catalog.

### **About this task**

To download content from the IBM Cloud Orchestrator Catalog, access the IBM Integrated Service Management Library and search for a solution.

To upload content to the IBM Cloud Orchestrator Catalog, access the Ready for IBM Tivoli software site and follow the validation process.

For additional information about content development, see the Content Developers Corner wiki.



---

## Appendix A. SCOrchestrator\_Toolkit

The SCOrchestrator\_Toolkit is delivered as a part of IBM Cloud Orchestrator. It provides the essential Business Process Manager building blocks, which are needed to build Business Process Manager business processes and human tasks, which are used as extensions for IBM Cloud Orchestrator.

If you want to write an extension for IBM Cloud Orchestrator, you must perform the following tasks:

- Ensure that the toolkit was imported into Business Process Manager, which is done by the IBM Cloud Orchestrator installer.
- Declare a dependency from your process application or toolkit to this toolkit.

The following building blocks are included with the toolkit:

*Table 6. Building blocks*

Building block	Section	Function
Business object	Data	Interface between IBM Cloud Orchestrator and Business Process Manager business processes that are provided as business objects within the toolkit. You can use them for parameter and private data declarations with Business Process Manager.
General system services, integration services, and web services	Implementation	Define Business Process Manager process extensions. They have a defined interface (input and output variable definitions) that are based on standard business objects that are provided by Business Process Manager and the SCOrchestrator_Toolkit.
Human services	User Interface	Sample UI extensions for an IBM Cloud Orchestrator extension. A Business Process Manager coach, which is included in a human service, defines a UI panel.
Set of sample Business Process Manager processes, human services, and other Business Process Manager artifacts	Tagged as SCOrchestrator_Samples, contain the 'Sample' prefix in their name.	Provide samples that show you how to use the building blocks that are delivered with the toolkit. Required to write operation extensions for IBM Cloud Orchestrator. Some samples are ready to use, other must be adapted. The documentation that is provided with every sample artifact includes information about how to use it.

---

## Business objects

The business objects provide a natural representation of the business data for application processing. You can use the business objects included in the `SCOrchestrator_Toolkit` to create custom objects.

The following business objects are delivered as part of the `SCOrchestrator_Toolkit`:

- `OperationContext`
- `ServiceInstance`
- `VirtualMachine`
- `NetworkInterface`

### Representation of long types in business objects

Long types are not supported by Business Process Manager. Therefore, the simple type business object `LongString` is introduced as a part of the `SCOrchestrator_Toolkit`.

It represents a long type that is encoded as a string. For a new business object that contains a long type, define a new variable with the data type `LongString`. Ensure that it has the same name as defined by the IBM Cloud Orchestrator object variable. An example is the variable `created` (`LongString`) found in the `CloudGroup`. When serializing JSON Objects to BPM business objects, the long typed variables are automatically mapped to the defined Business Object variables of type `LongString`. When deserializing business objects to JSON objects, the type `LongString` indicates the mapping to the origin data type `Long`.

## OperationContext

The operation context is an umbrella object that contains all data that is related to the execution of an operation. This operation context object must be defined as an input parameter variable for all business processes that are started as an extension for a IBM Cloud Orchestrator operation. Human services must define the operation context ID as an input parameter and as a first activity, must retrieve the operation context object with its ID.

The structure is as shown in the table:

*Table 7. OperationContext Structure*

Attribute	Data type	Description
id	String	The unique operation context identifier.
Status	String	The status of the task that is associated with the operation context.
eventTopic	String	The array that contains an object for each role.
description	String	The description of the ID.

Table 7. OperationContext Structure (continued)

Attribute	Data type	Description
Params	Map	The map that contains (key/value) pairs for storing arbitrary parameters. It can be used, for example, to hand over parameters that are collected from UI coaches in an extension Human Service to the associated Business Process. One of the most important keys in Params is the instances key that contains the instance IDs on which the instance actions execute. Use the integration services to fetch the instance IDs.
serviceInstance	ServiceInstance	Deprecated. Use the virtualMachines attribute instead.
user	String	The ID of the user in whose context the operation is executed
domain	String	The name of the domain in whose context the operation is executed
project	String	The name of the project in whose context the operation is executed
virtualMachines	Array of Object	The array contains an object for each managed virtual machine.

## Service Instance

Deprecated. Use the virtualMachines attribute instead.

## VirtualMachine

The VirtualMachine business object describes a virtual machine as part of a deployment.

It has the following structure:

Table 8. VirtualMachine structure

Attribute	Data type	Description
name	String	Deprecated.
cloudGroup	String	Deprecated.
networkInterfaces	NetworkInterface (List)	A list of network interfaces that the virtual machine is equipped with.

Table 8. VirtualMachine structure (continued)

Attribute	Data type	Description
hostname	String	The primary host name for the virtual machine. If there are multiple network interfaces, the primary host name is implementation-dependent.
virtualCpu	Integer	Deprecated.
memory	Integer	Deprecated.
disk	Integer	Deprecated.
imageId	String	Deprecated.
parameters	Map	Deprecated.
Id	String	Deprecated.
keypair	String	The name of the key pair for accessing the virtual machine.

## NetworkInterface

The NetworkInterface business object describes a network interface of a virtual machine.

It has the following structure:

Table 9. NetworkInterface Structure

Attribute	Data type	Description
ip	String	The IPv4 address in dotted decimal notation or the IPv6 address.
hostname	String	Deprecated.
ipgroup	String	Deprecated.
type	String	Deprecated.

---

## Services

To simplify parameter handling, most of the REST calls to IBM Cloud Orchestrator have a JSON object that is coded as a string in the input and output parameters. The activities of Business Process Manager Business Processes and Services operate on complex business objects. Therefore, building blocks are needed to convert a business object to a JSON string and vice versa.

The different types of services are general system services, integration services, and web services.

- The general system services used are as follows:
  - CreateBusinessObject\_OperationContext
  - GetErrorMessage
  - GetInputParameter
- The integration services used are as follows:
  - CreateBusinessObject\_ServiceInstance

- GenericBPDInvocation
  - GenericRestCall
  - GetInstanceIdFromOperationContext
  - GetMultipleInstanceIdsFromOperationContext
  - ReadBusinessObject
  - ReturnParameters
  - SetOperationContextParameters
  - UpdateInstancesParmInOperationContext
  - WriteValuesToBO
- The web service that is used is GenericBPDInvocationWS.

## General system services

The general system services of the Business Process Manager are defined along with their input and output variables.

### CreateBusinessObject\_OperationContext

The CreateBusinessObject\_OperationContext service creates a business object of type OperationContext based on a JSON input string.

Table 10. CreateBusinessObject\_OperationContext Input Variables

Input Variable	Data type	Description
operationContextString	String	JSON string that represents the operationContext

Table 11. CreateBusinessObject\_OperationContext Output Variables

Output Variable	Data type	Description
operationContext	OperationContext	It is a OperationContext business object

### GetErrorMessage

The GetErrorMessage general system service receives as input an error XML element, which is returned by the variable *tw.system.step.error*. It extracts and returns the error message and stack trace from the XML element as output variables.

Table 12. GetErrorMessage Input Variable

Input Variable	Data type	Description
error	XMLElement	The XMLElement variable containing the error exception information as returned by <i>tw.system.step.error</i> variable.

Table 13. GetErrorMessage Output Variable

Output Variable	Data type	Description
errorMessage	String	The error message extracted from the XMLElement input variable.

Table 13. *GetErrorMessage Output Variable (continued)*

Output Variable	Data type	Description
stackTrace	String	The stack trace extracted from the XMLElement input variable.

## GetInputParameter

The GetInputParameter general system service retrieves the inputParameterObject of Business Process Manager business process. The inputParameterObject is used as a workflow extension for IBM Cloud Orchestrator. It must be the first activity in each business process to be used as workflow extension for IBM Cloud Orchestrator.

Table 14. *GetInputParameter Input Variable*

Input Variable	Data type	Description
operationContext	OperationContext	The operation context object.
inputParameterObject_In	ANY	The inputParameterObject of the process must be mapped to this variable. It is required to enable a process to be called as linked process by another process. In this case, the inputParameterObject_In is not null. In all other cases, the inputParameterObject is null, which indicates that the process is called directly from the Cloud Orchestrator UI.

Table 15. *GetInputParameter Output Variable*

Output Variable	Data type	Description
inputParameterObject	ANY	The inputParameterObject contains the input parameters for the business process as collected by the associated human service.

## Integration services

You define the integration services of the Business Process Manager together with their input and output variables.

### CreateBusinessObject\_ServiceInstance

The CreateBusinessObject\_ServiceInstance service creates a business object of type ServiceInstance that is based on a JSON input string.

Table 16. *CreateBusinessObject\_ServiceInstance input variable*

Input Variable	Data type	Description
jsonString	String	JSON string that represents the service instance

Table 17. CreateBusinessObject\_ServiceInstance Output Variable

Output Variable	Data type	Description
serviceInstance	ServiceInstance	Service Instance Business Object

## GenericBPDIInvocation

The GenericBPDIInvocation service is used internally by IBM Cloud Orchestrator to do some housekeeping actions, such as mapping parameters that are encoded as JSON strings to business objects. Finally, it calls the customer extension Business Process.

## GenericRestCall

The GenericRestCall service is based on a Java implementation for a generic REST Call on IBM Cloud Orchestrator.

By default, it extracts the authentication information from the security context. The authentication information uses it to construct the security authentication token (Simple Token) for the REST calls that are made to external systems. As `tw_admin` is an internal user, GenericRestCall translates `tw_admin` to a default admin user for external calls. For more information about business process security, see “Business Process Manager security” on page 18. The GenericRestCall also accepts a user name on behalf of which a REST call must be made. It is especially useful for REST calls in the System Lane of a Business Process. They run by default as an admin user. It is desirable to run these REST calls on behalf of the person who submitted the request. To do that, map the user and project variables from the operation context to the GenericRestCall

Table 18. GenericRestCall input variables

Input Variable	Data type	Description
restMethod	String	The methods, such as POST, PUT, GET, and DELETE
jsonString	String	The input for PUT or POST encoded as a JSON string
restUrl	String	The REST URL that follows the host name (after <code>http://&lt;hostname&gt;</code> . For example, <code>/resources/clouds</code> .
iwidUser	String	The user name on behalf of which the REST call must be made. If not specified, the following users are considered: <ul style="list-style-type: none"> <li>• If it is run in the context of Business Process Manager user interface, the logged in user is used.</li> <li>• In case it is for activities that run in the System Lane of a business process, admin user is used.</li> </ul>

Table 18. *GenericRestCall* input variables (continued)

Input Variable	Data type	Description
domain	String	The domain name for the REST call context. If not specified, the default domain is used
project	String	The project name for the REST call context. If not specified, the user default project is used

Table 19. *GenericRestCall* output variable

Output Variable	Data type	Description
returnFromRest	String	Result of a REST call that is encoded as a JSON string

## GetInstanceIdFromOperationContext

The `GetInstanceIdFromOperationContext` integration service is used to fetch the instance ID from the given `OperationContext` object. For information about using instance data, see “Using instance data provided by `OperationContext`” on page 13.

Table 20. *GetInstanceIdFromOperationContext* input variable

Input Variable	Data type	Description
operationContext	OperationContext	The <code>OperationContext</code> business object.

Table 21. *GetInstanceIdFromOperationContext* output variable

Output Variable	Data type	Description
instanceId	String	The instance ID from the <code>OperationContext</code> object.

## GetMultipleInstanceIdsFromOperationContext

The `GetMultipleInstanceIdsFromOperationContext` integration service is used to fetch the instance IDs from the given `OperationContext` object. For information about using instance data, see “Using instance data provided by `OperationContext`” on page 13.

Table 22. *GetMultipleInstanceIdsFromOperationContext* input variable

Input Variable	Data type	Description
operationContext	OperationContext	The <code>OperationContext</code> business object.

Table 23. *GetMultipleInstanceIdsFromOperationContext* output variable

Output Variable	Data type	Description
multipleInstanceId	String (List)	The list of instance IDs from the <code>OperationContext</code> object.

## ReadBusinessObject

The service converts a business object into a JSON string so that it can be used. For example, as parameter for a REST call. It is a generic method that gets ANY business object as input parameter.

**Restriction:** The business object that is specified as input parameter must not have a parameter of type Map.

Table 24. ReadBusinessObject input variable

Input Variable	Data type	Description
BusinessObject	ANY	The business object to be converted into JSON string

Table 25. ReadBusinessObject output variable

Output Variable	Data type	Description
jsonString	String	Hypervisor Business Object that is converted into a JSON string.

## ReturnParameters

The ReturnParameters integration service is used to return parameters that are collected by a human service. The collected parameters are used as input parameters for the associated process. It must be the last activity of a human service that collects parameters for a business process, which is used as a workflow extension for IBM Cloud Orchestrator.

**Note:** The outParameterObject business object must be of the same business object type as the inputParameterObject of the associated process. The type is used by IBM Cloud Orchestrator to correlate a human service with its associated business process.

Table 26. ReturnParameters input variable

Input Variable	Data type	Description
operationContextId	String	ID of the operation context
outParameterObject	ANY	A business object that contains the parameters that are collected by the human service. They are used as input parameters for the associated business process.

Table 27. ReturnParameters output variable

Output Variable	Data type	Description
returnString	String	Result of REST call that is encoded as JSON String.

## SetOperationContextParameters

The SetOperationContextParameters integration service helps to enable the workflow of IBM Cloud Orchestrator extension to access and use parameters that

are collected by a human service. It stores the input parameter map as key/value pairs into the parameter section of the operation context for the specified operationContextId. This parameter is later given as input parameter to the Business Process Manager Business Process extension. The parameter 'startTask' specifies whether the Business Process Manager workflow must be triggered by the execution of this integration service (true) or not (false). If false is selected, several consecutive calls can be made by a human service extension to store the parameters that are collected into the OperationContext of the task. This activity is done before the Business Process Manager workflow process starts.

**Note:** This integration service is used internally to implement the ReturnParameters integration service. Normally, it must not be used directly by the human service that is associated with a workflow extension. Instead, the higher-level integration service ReturnParameters must be used.

*Table 28. SetOperationContextParameters input variable*

Input Variable	Data type	Description
operationContextId	String	ID of the operation context
params	Map	Map of parameters to be given as input parameter for the associated business process.
startTask	Boolean	True if the associated business process must be started (default false)

*Table 29. SetOperationContextParameters output variable*

Output Variable	Data type	Description
returnString	String	Result of REST call that is encoded as JSON String.

## UpdateInstancesParmInOperationContext

The UpdateInstancesParmInOperationContext integration service must be used after a create operation to update the instances parameter in the OperationContext object, so that any subsequent GetOperationContext call uses this ID to update instance data such as virtualMachines, if applicable. For information about using instance data, see “Using instance data provided by OperationContext” on page 13.

*Table 30. UpdateInstancesParmInOperationContext input variable*

Input Variable	Data type	Description
taskId	String	The ID of the task. For example, the operationContextId.
providerInstanceId	String	The providerInstanceId of the instance.
providerType	String	The type of the resource of the instance. For example: heat, openstackvms.

Table 31. UpdateInstancesParmlnOperationContext output variable

Output Variable	Data type	Description
parms	Map	The updated instances parameter in the OperationContext object.

## WriteValuesToBO

The service gets a JSON string representation of a business object as input variable and generates the corresponding TWork Business Object.

**Restriction:** Using 'ANY' for the type of the output variable business object leads to an error in Business Process Manager. The business object type of the output variable (for example, Hypervisor) must be specified explicitly. Therefore, if you are using a Business Object other than 'Hypervisor', the integration service must be copied from the toolkit to your Business Process Application. You must adapt the type of business object to the special context.

Table 32. WriteValuesToBO input variable

Input Variable	Data type	Description
BusinessObject	ANY	The business object to be converted into JSON string

Table 33. WriteValuesToBO output variable

Output Variable	Data type	Description
jsonString	String	The business object that is converted into a JSON string.

## Cloud management services

IBM Cloud Orchestrator offers cloud management services, for example, backup services or server restart.

### Approval

The cloud management services require approvals. The approval is implemented by the human service and coach of the Business Process Manager technology. It is a building block of the SCOrchestrator\_Toolkit.

Table 34. Approval Input Variable

Input Variable	Data type	Description
requester	String	Approval requester
parameters	NameValuePair (List)	List of parameters for approvals. The list of parameters in the form of name-value pairs that are shown as extra information in the approval UI panel.

Table 35. Approval Output Variable

Output Variable	Data type	Description
reason	String	Reason for approval or reject as specified in UI approval panel.
isApproved	Boolean	Approved (true) or not (false)

Instead of Business Process Manager Coach UI technology, the Cloud Orchestrator UI implements the approval panels. These approval panels show only the data from the Business Process Manager 'Approval' human service. You can use predefined approval building blocks to build your own approval Business Process to display information that the approver needs to make a decision. The sample Business Processes that are delivered as part of the toolkit, such as `Sample_DeployInstanceApproval` and `SampleDeleteInstanceApproval` can be copied and then customized to your needs. This customized approval Business Process can then be enabled by registering it in the **Orchestrator Actions** .

**Related information:**

[http://www.ibm.com/support/knowledgecenter/SSFTDH\\_8.5.0/com.ibm.wbpm.main.doc/ic-homepage-bpm.html](http://www.ibm.com/support/knowledgecenter/SSFTDH_8.5.0/com.ibm.wbpm.main.doc/ic-homepage-bpm.html)  
 • IBM Business Process Manager documentation

<http://www.scribd.com/doc/92505753/IBM-Impact-2011-Five-Guidelines-to-Better-Process-Modeling-for-Execution-Stuart-and-Zahn>  
 IBM Impact 2011 - Five Guidelines to Better Process Modeling for Execution - Stuart and Zahn

[http://www.ibm.com/developerworks/websphere/library/techarticles/1105\\_ragava/1105\\_ragava.html](http://www.ibm.com/developerworks/websphere/library/techarticles/1105_ragava/1105_ragava.html)  
 Developer Works: WebSphere Lombardi exception handling and logging - Gopalakrishnan Ragava and Sateesh Balakrishnan

## Samples

A number of samples are delivered as part of the `SCOrchestrator_Toolkit`. You must adapt the samples to your needs before they are run. You can find the actual samples documentation by opening the Business Process Manager process center (<http://<ico-server-IP>:9080/ProcessCenter/login.jsp>) and selecting the `SCOrchestrator_Toolkit`.

**Note:** Refer to the Business Process Manager documentation to know how to configure group membership and swim lane participation to achieve the required rights for the user you want to grant access to for requests like approval or problem handling.

### Sample\_AssignProblem

This sample process assigns the problem reported with sample process 'Sample\_ReportProblem' to a user of participant group 'Problem Administrator'. Make sure that there are users defined for participant group 'Problem Administrator'.

### Sample\_DeleteInstanceApproval

This sample process includes an approval. It can be embedded in a IBM Cloud Orchestrator deletion workflow. The intention is to approve the deletion process.

Make sure to also adapt the participant to the group which should have the approval right.

### **Sample\_DeployInstanceApproval**

This sample process includes an approval. It can be embedded in the IBM Cloud Orchestrator deploy instance workflow. The intention is to approve the deploy instance process. Make sure to also adapt the participant to the group which should have the approval right.

### **Sample\_Post\_ServiceInstance\_Data**

This sample process is to post ServiceInstance data, in this case parameters for Service Instance MetaData. The sample process first retrieves the ServiceInstance data as JSON String, creates a ServiceInstance Business Object and finally posts a parameter to the Service Instance MetaData.

**Note:** To run the process, the default value for the ServiceInstance ID has to be updated with a valid ServiceInstance ID.

### **Sample\_Process\_wo\_HumanService**

This sample extension is a process without human service. It displays the operation context business object in XML representation.

### **Sample\_TestMultiTenancy**

This sample is a simple test for REST calls within a process:

1. Using the default admin user context.
2. Using the caller's identity and domain/project scope that are stored in the operationContext.

### **Template\_BusinessProcess**

This sample template helps to create a Business Process Manager Business Process that can be used either as orchestrator action (event triggered action or user action) or as self-service offering within IBM Cloud Orchestrator. You can start developing your own business process extension by copying this template and enhancing it with your implementation logic.

**Note:** The variable type of the input parameter inputParameterObject has to be changed from 'ANY' to the concrete Business Object data type to be used. Do not forget to expose the process (Expose to start) to make it visible in the Configuration panel of IBM Cloud Orchestrator.



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## Appendix B. Scripting utilities toolkit

The `SCOorchestrator_Scripting_Uilities_Toolkit` is delivered as a part of the IBM Cloud Orchestrator product. It provides the essential building blocks of the Business Process Manager. These building blocks are required to build Business Process Manager Business Processes and human tasks, which are used as extensions for IBM Cloud Orchestrator.

When you work with remote devices, such as remote virtual machines and storage hosts, copy and run scripts/batch files on remote servers are frequently needed tasks. The Cloud Orchestrator Scripting Utilities Toolkit provides implementation services that you can drag and drop during IBM Cloud Orchestrator Business Process Manager process creation. These services can be used to copy files to a remote system or execute command lines on remote systems, including uploaded scripts/batch files.

**Note:** This toolkit is not designed to work with systems configured with restricted shell access, for example `rbash`.

---

### File upload restrictions

You can only upload files that reside within a local file repository such as a local folder or locally mounted folder.

It is defined by the toolkit environment variable `localRepositoryBasePath`. By default, this variable is defined as `/var/ibm/sco/scriptRepo`.

For security reasons, the processes of the toolkit check whether the files to be uploaded are always within the repository base folder.

---

### Business objects

These business objects are delivered as part of the `SCOorchestrator_Scripting_Uilities_Toolkit`.

Some of the business objects are partly reused within other business objects.

- `RemoteMachineCredentials`
- `UploadFileData`
- `ExecuteCommandData`
- `OutputMapValues`

## ExecuteCommandData

Data to define a command line execution task.

Table 36. ExecuteCommandData

Parameters	Data type	Description	Sample data
commandLine	String	Command to be executed on the remote machine. This might also be a shell or batch script.	"ls -l"
workingDirectory	String	The processes change the current directory to the given working directory, before the command is executed.	"/tmp/test"
operatingSystemType	String	The type of operating system. The allowed values are "Windows" and "Linux/Unix".	
ipAddress	String	IP address of the target machine.	
subnetMask	String	Wildcard Card Entry for IP address.	"*22"
userId	String	UserID of the target machine.	
Password	String	Password of the target machine.	

## OutputMapValues

Data object that holds well-defined return parameters of a called process.

Table 37. OutputMapValues

Parameters	Data type	Description	Sample data
errCode	String	Empty string if no error occurred by processing the implementation service. Otherwise an error code is returned.	"CTJCA1699E"
errMsg	String	Empty string if no error occurred by processing the implementation service. Otherwise an error message is returned.	"Details about the problem"
retCode	String	Contains the return code of the called command.	"0"

Table 37. *OutputMapValues* (continued)

Parameters	Data type	Description	Sample data
stdOut	String	Contains the standard output of the called command.	">script called"
stdErr	String	Contains the standard error output of the called command.	"file is not executable"

## Implementation services

The toolkit contains a number of implementation services.

The implementation services are described in separate topics. The following implementation services are used only internally and are not described in detail:

- Decrypt\_Text
- Encrypt\_Text

For more information about the services, see the documentation inside the toolkit or service itself.

The implementation services of the toolkit are as follows:

### SSH\_UploadFile

This integration or implementation service uploads a file to a remote machine through SSH protocol.

Table 38. *SSH\_UploadFile*

Input parameters	Data type	Expected value	Sample data
remoteMachine	String	Remote machine IP address or host name	"9.120.xxx.xxx"
userName	String	Log in user name for the SSH protocol	"root"
password	String	Login password. Optional. See Table 39 on page 48.	"*****"
PrivateKey	String	RSA-Key. Optional. See Table 39 on page 48.	"RSA-Key"
fileName	String	Name of the file to be uploaded from the local file repository	"HelloWorld.sh"
destinationPath	String	Full destination path in the format of the remote machine	"/tmp/destination"
localRepositorySubDir	String	Subdirectory or NULL/Empty string. See "File upload restrictions" on page 45.	"/SubFolder/"

Table 38. SSH\_UploadFile (continued)

Input parameters	Data type	Expected value	Sample data
makeFileExecutable	Boolean	Make the file executable for "Implementation-Service" user (ignored on Windows operating systems)	"True"

Table 39. Optional parameters

Optional parameters
<b>Password="value" / PrivateKey=ignored</b> For the connection to the remote machine, the credentials "user" and "password" are used.
<b>Password=empty / PrivateKey=empty</b> If the private key of the Business Process Manager machine is inserted into the trusted list of keys within the remote machine, it is also possible to connect on this trusted relationship. In this case, the password field must be left empty to identify this connection mode.
<b>Password=empty / PrivateKey="value"</b> If another trusted private key must be used to enable the connection than it can be passed as a parameter. For this mode, the password must be left empty.

Table 40. General output parameter map for most of the implementation services

Output parameters	Data type	Expected value	Sample data
OutputMap	Map (Key-,Value-String)	Results of the specific implementation service	See individual samples

Table 41. Possible keys and their values

Key string or key value	Expected value	Value string or sample data
errCode	Error code, if error occurred	"CTJCA1699E"
errMsg	Error details, if error code is set	"Source file not available"
RC *	Return code of the called command line	"0"
stdOut *	Standard output of a called command line	"Hello world"
stdErr *	Standard error output of a called command line	"file/command not found"

\* These keys are only available for services with command line.

## SSH\_ExecuteCommand

This integration or implementation service runs a command line on a remote machine through SSH protocol.

Table 42. SSH\_ExecuteCommand

Input parameters	Data type	Expected value	Sample data
remoteMachine	String	Remote machine IP address or host name	"9.120.xxx.xxx"

Table 42. *SSH\_ExecuteCommand* (continued)

Input parameters	Data type	Expected value	Sample data
userName	String	Log in user name for the SSH protocol	"root"
password	String	Login password. Optional. See Table 39 on page 48.	"*****"
PrivateKey	String	RSA-Key. Optional. See Table 39 on page 48.	"RSA-Key"
commandLine	String	Command line or script file that must be run on the remote machine	"ls -l"
cmdLineWorkingDirectory	String	Full path in the format of the remote machine	"/tmp/destination"

For the output parameters, see Table 40 on page 48.

## SSH\_UploadFileAndExecuteCommand

This integration or implementation service:

- Uploads a file to a remote machine
- Runs a command line on a remote machine
- Through SSH protocol

Table 43. *SSH\_UploadFileAndExecuteCommand*

Input parameters	Data type	Expected value	Sample data
remoteMachine	String	Remote machine IP address or host name	"9.120.xxx.xxx"
userName	String	Log in user name for the SSH protocol	"root"
password	String	Login password. Optional. See Table 39 on page 48.	"*****"
PrivateKey	String	RSA-Key. Optional. See Table 39 on page 48.	"RSA-Key"
fileName	String	Name of the file to be uploaded from the local file repository	"HelloWorld.sh"
destinationPath	String	Full destination path in the format of the remote machine.	"/tmp/destination"
localRepositorySubDir	String	Subdirectory or NULL/Empty string. See "File upload restrictions" on page 45.	"/SubFolder/"

Table 43. *SSH\_UploadFileAndExecuteCommand* (continued)

Input parameters	Data type	Expected value	Sample data
makeFileExecutable	Boolean	Make file executable for "Implementation-Service" user. Ignored on Windows operating systems	"True"
commandLine	String	Command line or script file that must be run on the remote machine.	"ls -l"
cmdLineWorkingDirectory	String	Full path in the format of the remote machine.	"/tmp/destination"

For the output parameters, see Table 40 on page 48.

## Windows\_UploadFile

This integration or implementation service:

- Uploads a file to a remote machine
- Through RXA toolkit/protocol

Table 44. *Windows\_UploadFile*

Input parameters	Data type	Expected value	Sample data
remoteMachine	String	Remote machine IP address or host name	"9.120.xxx.xxx"
userName	String	Log in user name for the SSH protocol	"Administrator"
password	String	Log in password	"*****"
fileName	String	Name of the file to be uploaded from the local repository.	"HelloWorld.bat"
destinationPath	String	Full destination path in the format of the remote machine	"c:\tmp\destination\"
localRepositorySubDir	String	Subdirectory or null/empty string. See "File upload restrictions" on page 45.	"\SubFolder\"

For the output parameters, see Table 40 on page 48.

## Windows\_ExecuteCommand

This integration or implementation service runs a command line on a remote machine through RXA toolkit/protocol.

Table 45. *Windows\_ExecuteCommand*

Input parameters	Data type	Expected value	Sample data
remoteMachine	String	Remote machine IP address or host name	"9.120.xxx.xxx"

Table 45. *Windows\_ExecuteCommand* (continued)

Input parameters	Data type	Expected value	Sample data
userName	String	Log in user name for the SSH protocol	"Administrator"
password	String	Log in password	"*****"
commandLine	String	Command line or script file that must be run on the remote machine.	"dir"
cmdLineWorkingDirectory	String	Full path in the format of the remote machine	"c:\tmp\ destination\"

For the output parameters, see Table 40 on page 48.

## Windows\_UploadFileAndExecuteCommand

This integration or implementation service:

- Uploads a file to a remote machine
- Runs a command line on a remote machine
- Through RXA toolkit/protocol

Table 46. *Windows\_UploadFileAndExecuteCommand*

Input parameters	Data type	Expected value	Sample data
remoteMachine	String	Remote machine IP address or host name	"9.120.xxx.xxx"
userName	String	Log in user name for the SSH protocol	"Administrator"
password	String	Log in password	"*****"
fileName	String	Name of the file to be uploaded from the local file repository	"HelloWorld.bat"
destinationPath	String	Full destination path in the format of the remote machine	"c:\tmp\ destination\"
localRepositorySubDir	String	Subdirectory or NULL/Empty string. See "File upload restrictions" on page 45.	"\SubFolder\"
makeFileExecutable	Boolean	Make file executable for "Implementation-Service" user. Ignored on Windows operating systems	"True"
commandLine	String	Command line or script file that must be run on the remote machine	"dir"
cmdLineWorkingDirectory	String	Full path in the format of the remote machine	"c:\tmp\destination"

For the output parameters, see Table 40 on page 48.

## ExtractOutputMap

This integration or implementation service extracts the OutputMap values (Key-Value-Pairs) to concrete fields of a OutputMapValues object.

Table 47. ExtractOutputMap

Input parameters	Data type	Expected value	Sample data
OutputMap	Map of strings	See Table 40 on page 48.	
retValues	OutputMapValues	ErrCode errMsg retCode stdOut stdErr	See the samples in Table 41 on page 48.

For the output parameters, see Table 40 on page 48.

## FindVMInstanceForHostname

This integration or implementation service looks into the input VirtualMachine list, for a virtual machine instance with a specified host name (input) for a matching IP address and returns the virtual machine instance.

Table 48. FindVMInstanceForHostname Input Parameters

Input parameter	Data type	Expected value	Sample data
virtualMachines	List Of VirtualMachine	At least one virtual machine, with the IP address, host name populated. The KeyPair field is optional.	
hostname	String	Name of the virtual machine.	

Table 49. Output parameters

Output parameter	Data type	Expected value	Sample data
vmInstance	VirtualMachine	A virtual machine with the IP address, host name populated. The KeyPair field is optional.	
successMessage	String	Message when the operation is successful.	
failureMessage	String	Message when the operation fails.	

## FindVmInstanceForIPAddress

This integration or implementation service looks into the input VirtualMachine list for a virtual machine instance with a specified IP address (input) for a matching host name and returns the virtual machine instance.

Table 50. FindVmInstanceForIPAddress input parameters

Input parameters	Data type	Expected value	Sample data
virtualMachines	List Of VirtualMachine	At least one virtual machine, with the IP address, host name populated. The KeyPair field is optional.	
ipaddress	String	IP address of the virtual machine.	

Table 51. Output parameters

Output parameters	Data type	Expected value	Sample data
vmInstance	VirtualMachine	A virtual machine, with the IP address, host name populated. The KeyPair field is optional.	
successMessage	String	Message when the operation is successful	
failureMessage	String	Message when the operation fails	

---

## Sample processes

The SCOrchestrator\_Scripting\_Uilities\_Toolkit contains sample processes, which are based on tasks, targeted against a single virtual server machine.

For output data for all of the samples, see *General Output Parameters (parameter map)* in “Business objects” on page 45.

For input data for the sample, see the business object references in the following list:

### VirtualMachine\_ExecuteCommand

For input data, refer to the ExecuteCommandData.

---

## Sample UIs

The `SCOrchestrator_Scripting_Utilities_Toolkit` contains sample UIs, which reflect the needs of the corresponding sample processes.

The sample processes and their matching sample UI are related by their corresponding business object.

The type of output parameter of the sample UI must match the type of input parameter of the sample process.

The sample UI is:

### **VirtualMachine\_ExecuteCommand**

For input data, refer to the `ExecuteCommandData`.

---

## Appendix C. Support IaaS toolkit

The `SCOrchestrator_Support_IaaS_Toolkit` provides capabilities that enable the user to perform operations on the IaaS layer in IBM Cloud Orchestrator. The toolkit provides two different ways to perform the API calls:

- An integration service "Generic IaaS Rest Call" that can be used to authenticate and perform REST calls against any IaaS services in specified regions. The requests can be performed on behalf of a user in a domain and project. It is the most flexible and documented way to perform REST calls to OpenStack services through an IaaS gateway.
- An integration service "Get IaaS Regions" that retrieves the list of available regions in a multi-region cloud environment. There exists a helper method in the `iaas_util.js` file that implements the authentication routine based on the configured shared secret keys in the WebSphere run time.

The toolkit provides building blocks that can be used in custom toolkits and process applications. These building blocks are required to build Business Process Manager Business Processes and human tasks, and are also used as extensions. IBM Cloud Orchestrator uses these extensions for actions against the IaaS layer. For information about IaaS layer, see APIs provided by OpenStack and IaaS gateway. The toolkit provides an essential Java REST client API and samples that show how to use the API in Business Processes. To write an extension for IBM Cloud Orchestrator, perform these mandatory tasks:

- Import this toolkit into Business Process Manager.
- Declare a dependency from your Process Application / toolkit to this toolkit.

The following building blocks are provided by this toolkit:

- Libraries (in the Files section of the toolkit) - the libraries contain the Java classes that implement the client-side of the OpenStack and Cloud IaaS gateway API. The libraries contain Java implementation of resources and methods. These resource implementations and methods can be used in human services and business processes for actions against the OpenStack and IaaS gateway.
- Samples - the toolkit provides samples that illustrate the usage of the client-side API. For example, the toolkit provides a sample to create and delete a tenant to the OpenStack identity service Keystone. Another example is about the modification of the metadata of a server. The samples are implemented based on default Business Process Manager artifacts. It includes the following elements:
  - Business objects (BOs) (in the Data section of the toolkit) - some sample objects that are used in the sample Business Process Manager Processes that illustrate the flow of data between Business Process Manager and the OpenStack or IaaS gateway. You can easily use them for parameter and private data declarations with the standard Business Process Manager. For example, business objects can represent tenants and servers.
  - Human services (in the User Interface section of the toolkit) - some sample human services and coaches are implemented to illustrate the usage of the API. For example, human services can specify the parameters of a tenant that are required to create the tenant. Another example is to select a server that exists in OpenStack. It shows its details and modifies its metadata.
  - Business Process Manager- some sample processes that illustrate the usage of long-running tasks. These processes include, for example, the creation and deletion of a tenant and the modification of the metadata of a server.

- Integration services - the toolkit provides the following integration services:
  - REST API calls against OpenStack and IaaS gateway
  - Retrieve the list of available OpenStack regions
- Authentication Routines - authenticate with the OpenStack identity service through the IaaS gateway.

---

## Generic IaaS REST call

The IaaS Generic REST call makes REST calls to OpenStack services through the IaaS gateway. You can use the interface to specify the target region and service to start, for example, the compute service Nova in the US-West region. The interface is not typed and therefore expects and returns a string in a JSON format.

This generic interface allows any RESTful calls against the OpenStack APIs by specifying the URL and JSON response.

The authentication of the client is done by using the shared secret key, which is configured at run time of the Business Process Manager. The shared secret is used to generate a token for the admin user, which is used for authentication.

The integration service provides the following input variables:

### **restMethod**

The method of the REST call, supported types are GET, POST, PUT, PATCH, and DELETE. It is a required property.

### **iaasServiceType**

The type of the service that is instantiated and used to start the REST call. Examples for the service types are `identity` for keystone, `compute` for Nova, `image` for glance. It is a required property.

### **iaasEndpointType**

The endpoint of the service to use. It is a required property. The supported values are

- For v2: `adminURL`, `publicURL` (default), and `internalURL`.
- For v3: `admin`, `public` (default), and `internal`.

### **iaasRegion**

The region from which the service is instantiated, for example, `RegionOne`. It is an optional property. The first region that is found is taken by default.

### **restUrl**

Defines the REST resource that must be started. For example, `/tenants` or `/user/{user-id}`. It is a required property.

### **restJsonContent**

The content that must be posted or put to the REST URL. The string must have a valid JSON format as defined in the IaaS API. It is a required property.

### **iaasUser**

The user of this request. It is an optional property. The default is `admin`.

### **iaasProject**

The project that performs the request. The user is authenticated and the scope of the user for this project is determined. This property is optional. The default is `admin`.

**iaasDomain**

The domain of the user is authenticated. The user can only be uniquely determined by specifying the domain. This property is optional. The default is Default.

The output variable of the integration service is

**restJsonResponse**

The response of the REST call as a string in JSON format.

## OpenStack and Cloud API library in Business Process Manager

The OpenStack and Cloud library contain Java classes that can be used to interact with the OpenStack and Cloud IaaS gateway. The Java classes and methods can be used in any Java or JavaScript implementation in any of the Business Process Manager artifacts. The basic concepts of how to use the library within Business Process Manager are covered here.

**Note:** To allow the usage of Java implementations in JavaScript implementation, the Business Process Manager uses **LiveConnect**. During Java class access, it requires a fully qualified package name because the engine must look up the classes.

For example, to create an instance of the OpenStackConnectionFactory for a given host (String), the full package name must follow the Packages keyword:

```
var connectionFactory = Packages.com.ibm.openstack.api.OpenStackConnectionFactory.newInstance(host);
```

To simplify the usage and avoid having to add the full package name for each variable, the developer can use the JavaScript by omitting the type definition. In this example, the object of type `com.ibm.openstack.api.OpenStackConnectionFactory` is stored in the local variable `connectionFactory`. Next, the variable can be used as described in the API reference of the OpenStack and Cloud library. For example, to set up a connection for a user and password (both variables of type String) -

```
var connection = connectionFactory.newConnection(username, password);
```

Follow this pattern and the API reference to implement activities of type JavaScript in human services or processes to do actions against the IaaS layer. The next sections focus on authentication and actions against OpenStack and IaaS gateway.

## Get IaaS Regions

The Get IaaS Regions integration service uses the generic IaaS client to retrieve the list of available regions. These regions can be used to find IaaS services, for example, the compute service in the US-West region.

The integration service does not require any input parameters. The output parameter is

**-regions**

a list of region names that are available.

**Related concepts:**

“Generic IaaS REST call” on page 56

The IaaS Generic REST call makes REST calls to OpenStack services through the IaaS gateway. You can use the interface to specify the target region and service to start, for example, the compute service Nova in the US-West region. The interface is

not typed and therefore expects and returns a string in a JSON format.

---

## Samples for the IaaS support toolkit

The sample IaaS support toolkit provides basic samples for the IaaS support toolkit. The samples are available via the **Sample IaaS Support Process App** process application which is installed together with the IaaS support toolkit by default.

The following samples are available:

### Sample Create Domain

This sample shows how to create a new domain entity in the v3 API of the identity service in Keystone. It assumes that Keystone v3 is enabled in the service catalog. The samples also demonstrates how to create a new 'Default' project for the domain and adding the admin user as a member to the project.

### Sample Delete Domain

This sample shows how to delete a domain entity in the v3 API of the identity service in Keystone. The human service shows how to select a domain out of the list of domains. The process disables the domain and deletes it afterwards.

### Sample Create Project

This sample shows how to create a project entity in the v3 API of the identity service in Keystone. The human service shows how to specify the project details and checks whether the project already exists. The process creates a project in Keystone.

### Sample Delete Project

This sample show how to delete a project entity in the v3 API of the identity service in Keystone. The human service shows how to select a project out of the list of project . The process deletes the projects in Keystone.

### Sample Project On-Boarding

This samples shows how to configure a new or existing project in Cloud Orchestrator. The purpose of the sample is to show the API calls to configure the project to be operational. Therefore, the human services is a wizard that steps the users through a list of steps to:

- Create or select the project entity in Keystone
- Configure the quota of the project
- Add users and roles to project
- Grant access to environment profiles, patterns, and images to the project
- Grant access to self-service offerings and operation actions to the project

### Sample Create User

This sample shows how to create a user entity within a domain in the v3 API of the identity service in Keystone. The human service shows how to specify the user details, how to select the domain, and how to select the default domain and role. The human service checks if the user already exists. The process creates the user in the selected domain and assigns the selected project to the user with the role specified.

### Sample Delete User

This sample show how to delete a user entity in the v3 API of the identity

service in Keystone. The human service shows how to select a user from the list of users. The process deletes the user in Keystone.

---

## Sample to create a tenant in OpenStack identity service

The sample shows how to create a tenant. A business object is created and it contains the required parameters, such as name and description. It is assumed that the `inputParameterObject` is instantiated with the business object of type `Tenant`.

The code to create a tenant is as follows:

```
// authenticate using the helper method in iaas_utils.js
var connection = authenticateIaaS(tw.env.iaas_host, tw.env.iaas_user,
    tw.env.iaas_password, tw.env.iaas_tenant,
    tw.env.iaas_use_gateway);

// lookup the first identity admin service
var serviceFactory = Packages.com.ibm.openstack.api.
    service.OpenStackServiceFactory.
    newInstance(connection);
var identityAdminServices = serviceFactory.lookupServices
    (Packages.com.ibm.openstack.api.service.
    IIdentityAdminService);
var identityAdminService = identityAdminServices.get(0);

// create a new resource of type tenant
var factory = Packages.com.ibm.openstack.api.model.
    identity.IdentityFactory.eINSTANCE;
var tenant = factory.createTenant();

// initialize the tenant resource object with the
// attributes from the inputParameterObject
tenant.setName(tw.local.inputParameterObject.name);
tenant.setDescription(tw.local.inputParameterObject.description);
tenant.setEnabled(tw.local.inputParameterObject.enabled);

// call the identity admin service to create a new tenant
tenant = identityAdminService.createTenant(tenant);

// store the Id of the new tenant as a reference
// in the inputParameterObject
tw.local.inputParameterObject.id = tenant.getId();

// adapt authentication method -
// authentication based on the webshpere configuration settings
// using the helper method in iaas_utils.js
var connection = authenticateIaaS();
```

---

## Sample to get a list of servers from OpenStack compute service

See how to get a list of servers from OpenStack compute service.

**Note:** This example is a single region example.

The example code gets the details of a server, and the logic of the steps are as follows:

1. Authenticate to the identity service.
2. Look up the compute service.
3. Get a list of all servers.

When the connection is established, the system must look up a compute service, which is registered in the service catalog of the identity service.

```

// get the service factory based on the connection
  (knows the identity service and the catalog)
var serviceFactory = Packages.com.ibm.openstack.api.service.
    OpenStackServiceFactory.newInstance(connection);
// lookup the compute services
var computeServices = serviceFactory.lookupServices
    (Packages.com.ibm.openstack.api.service.IComputeService);
// pick the first compute service
var computeService = computeServices.get(0);

```

In the next step, you get the list of servers and fill a local list. The list contains Business Process Manager Business Objects (BOs) that are created in the process application or toolkit to hold values. This list can then be used in UI elements, for example, as "selection box" (see the **Sample Play with VM** human service). The business object of type server can be found in the IaaS Support Toolkit. It has the attributes id and name of type string. The following code fills the list of servers with the list of servers that are retrieved from the compute service.

```

// the list of servers from compute service
var servers = computeService.getServers();
// a local variable of type Server in the process or human service
tw.local.servers = new tw.object.listOf.Server();
// iterate through the list of servers retrieved from compute service
for (var i=0; i<servers.size(); i++) {
    var s = new tw.object.Server(); // instantiate a new BO
    s.id =servers.get(i).getId(); // copy the id
    s.name=servers.get(i).getName(); // copy the name
    tw.local.servers.insertIntoList(i, s);
}
// add the new instance to the local list

```

Examples of how to obtain more details of a server can be found in the **Get Server Details** activity in the **Sample Play with VM** human service.

---

## Troubleshooting

Read the following considerations about troubleshooting the toolkit.

The pattern designers use patterns to do actions against an OpenStack service, which has a benefit on simplification and time-to-value. The library provides a typesafe implementation of the OpenStack API, which is less error-prone and more comfortable than using REST calls and parsing JSON responses. However, this pattern has the following implications:

- The Business Process Manager documentation denotes performance implication in the usage of **LiveConnect**.
- Debugging is difficult.
- The Java script editor has no code completion and syntax highlight.

As a workaround for these implications, encapsulate the code in integration services or general system services. They are Java implementations of routines that are provided by Business Process Manager.

---

## Appendix D. Email notification toolkit

The `SCOrchestrator_Email_Notification_Toolkit` is delivered as a part of Cloud Orchestrator. It provides the essential building block for sending email notifications with improved usability.

**Note:** An SMTP server via a `100Custom.xml` must be configured. The email notification toolkit uses this configured SMTP server value to send email notifications. For information about how to configure SMTP, see [Configuring the SMTP server](#).

Using the toolkit, you can:

- Send .HTML message files
- Send `messagetext` in HTML format
- Send `messagetext`
- Attach a list of files
- Send to a list of recipients' email addresses
- Send to list of cc recipients' email addresses

**Note:** Defined custom variables are automatically substituted by values.

---

## Business objects

These business objects are delivered as part of the `SCOrchestrator_Email_Notification_Toolkit`.

### EmailTemplate

Table 52. *EmailTemplate*

Parameters	Data type	Description	Sample data
subject	String	Email subject	Message subject text
message	String	Email message text	Filename of html file (" <code>/tmp/email.html</code> "), message-text in html format, or message text
mimeType	String	Email type of messagepart	"text/html"
to	String	List of recipients' email addresses	"mailto:localhost"
cc	String	List of cc recipients' email addresses	"mailto:localhost, mailto:localhost" (recipients listed with separating comma or space)
from	String	Sender's email address	"root@localhost"
attachmentFiles	String	List of attached files	"/tmp/ibm-logo,/tmp/cloud.jpg"
variablepair (NameValuePair): - name(String) - value(String)	List	List of Email-Variable value pairs for substitution	[{"name": "\$FIRSTNAME", "value": "xxxxx"}, {"name": "&LASTNAME", "value": "yyyyy"}]

## tw.local.status

Table 53. Status

Output variable	Data type	Description	Return codes
tw.local.status. tw.local.status == 0	Integer	Indicates the successfully executed building block to send an email. Status of executed process.	-1 missing message template xxx.html -2 missing attachment file -3 missing 'to' recipient email-address -4 missing sender email-address -5 other failures

## Implementation services

The toolkit contains a number of implementation services.

The following implementation services are used only internally and are not described in detail:

- Read File
- Send File

For more information about the services, see the documentation inside the toolkit or service itself.

The implementation services of the toolkit are as follows:

### Send Email Template

This implementation service prepares the message and message-text and sends it to the recipients' email addresses.

Table 54. Send Email Template

Parameters	Data type	Description	Sample data
subject	String	Email subject	Message subject text
message	String	Email message text	<ul style="list-style-type: none"><li>• Filename of html file: "/tmp/email.html" or</li><li>• message-text in html format or</li><li>• message text</li></ul>
contentType	String	Email type of messagepart	"text/html"
to	String	List of recipients' email addresses	"mailto:localhost"
cc	String	List of cc recipients' email addresses	"mailto:localhost1,mailto:localhost2" (recipients listed with separating comma or space)
from	String	Sender's email address	"root@localhost"
attachmentFiles	String	List of attached files	"/tmp/ibm-logo,/tmp/cloud.jpg"

---

## Sample processes

The SCOrchestrator\_Email\_Notification\_Toolkit contains the sample process **Sample Send Email from Template**.

For output data and input data for **Sample Send Email from Template**, see the **EmailTemplate** business object in “Business objects” on page 61.

---

## Sample UI

The SCOrchestrator\_Email\_Notification\_Toolkit contains sample UIs, which reflect the needs of the corresponding sample processes.

The sample processes and matching sample UIs are determined by their corresponding data object. The type of output parameter of the sample UI must match the type of input parameter of the sample process. The sample UI is **Sample Send Email Notification**. For output data, see the **EmailTemplate** business object in “Business objects” on page 61.



---

## Appendix E. OpenStack Cinder Storage Volumes toolkit

Using the IBM Cloud Orchestrator Content Pack for OpenStack Cinder Storage Volumes, you can manage the lifecycle of block storage volumes through the OpenStack Cinder service. You can manage the block storage volumes in IBM Cloud Orchestrator deployed instances.

---

### Installing and configuring

A good knowledge of IBM Cloud Orchestrator and of the Business Process Manager programming model is required for using the toolkit as a software development kit (SDK) for building new content.

This content pack comes installed in IBM Cloud Orchestrator. This means that the toolkit and the related offerings and actions are already available in the IBM Cloud Orchestrator environment.

Before starting to use this content pack, you must:

- On the OpenStack Controller that manages the region that you are working on, ensure that you have:
  - The OpenStack Cinder service up and running.
  - At least one storage backend that is configured on Cinder and a volume type that maps this backend. For instructions about how to configure a backend on Cinder and how to create volume types, see the OpenStack documentation.

---

### Toolkit scenarios

There are a number of scenarios that are immediately available from the toolkit.

First, you register the required Self-Service Offerings and Instance Actions, based on the configuration parameters specified in each of the scenarios.

The following scenarios are available:

- “Creating new volumes” on page 66
- “Attaching volumes” on page 66
- “Detaching volumes” on page 68
- “Deleting volumes” on page 68
- “Managing volumes related to a virtual system instance” on page 69

For more information about operation registration, see the following topics:

- Chapter 7, “Automating the creation of categories, offerings, and instance actions,” on page 25
- Orchestration workflows
- Working with self-service

Alternatively, you can use the Self-Service Catalog Population Tool to automatically register all of them at once.

## Creating new volumes

You can create new volumes in your instance.

This use case is available as a self-service offering.

To run this scenario, perform the following steps:

1. Go to the Self-Service Catalog and open the **Deploy cloud services** category.
2. Start the **Create volumes** offering.
3. Select the region and availability zone in which you want to create your volume.
4. Select a storage service level (volume type) from among the ones defined in the region that you have selected and click **Next**.
5. Insert the base name of your volume, choose the number of volumes that you want to create, provide an optional description, and enter the volume size in GB.

**Note:** If you create more than one volume, from the first volume, an increasing index is added as a suffix to the volume base name.

6. Click **Submit**.

Table 55. Configuration

<b>Name</b>	Create volumes
<b>Category</b>	Deploy cloud services
<b>Process</b>	Create Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)
<b>User interface</b>	Create Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)

## Attaching volumes

You can attach a volume in your project to a virtual machine and optionally format it as a single partition and mount it to a given mount point.

This use case is available as instance action applicable to a volume resource instance. The volume instance must be in available status.

To run this scenario, perform the following steps:

1. Go to the volume resource view by clicking the **RESOURCES** tab and then clicking the **Volumes** icon.
2. Select an available volume.
3. Click the **Attach volumes** action.
4. Select a virtual machine from the list and click **Next**.
5. Select **Format volume** if you want to format and mount the volume. If so:
  - a. Select the virtual machine operating system: Windows or Linux.
  - b. Select the file system type.
  - c. Enter the mount point.
  - d. Decide whether you want to connect to the machine by providing credentials, or by an SSH key that is stored in the keystore or by your own SSH key. For Windows operating systems, connection by using the SSH key is disabled. Click **Next**.

**Note:**

- You cannot enable this option for machines that are powered off.
  - This option is not supported for NIOS.
6. Check the summary and click **Submit**.

**Note:** For Linux operating systems, if you chose to mount the file system on which you have formatted the volume, no record in the `/etc/fstab` file is added. When you restart the machine, the file system is no longer mounted and you must mount it manually.

After having attached the volume, its format and mount options (if there are any) are stored in the volume metadata. Volume metadata also contains the file system label and UUID.

*Table 56. Configuration*

<b>Name</b>	Attach volume
<b>Instance type</b>	volumes
<b>Process</b>	Attach Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)
<b>User interface</b>	Attach Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)

**Note:** In the case where Microsoft Windows is the guest operating system, there might be situation where the default RXA connection timeout is too small. The result is that the volume is not correctly formatted and / or mounted within the guest operating system. If this was the case then you would see connection errors to the provisioned virtual machine in the `SystemOut.log`. The following property would need to be added to the custom properties of the Business Process Manager Java WebSphere Configuration:

```
com.ibm.tivoli.remoteaccess.connection_timeout_default_millis
```

If the provisioned virtual machine resides on a remote cloud that is managed by Public Cloud Gateway in addition refer to Public Cloud Gateway overview and Network planning.

The configuration steps are:

- Log on to `http://<IBM Cloud Orchestrator Node 1>.:9060/admin` using `bpm_admin`.
- Select **Servers -> All servers -> SingleClusterMember1 -> Java and Process Management -> Process definition -> Java Virtual Machine -> Custom properties**.
- Select the **New** button to add the following property:
 

<b>Property name</b>	<code>com.ibm.tivoli.remoteaccess.connection_timeout_default_millis</code>
<b>Value</b>	At least 180000 that is 3 minutes. Time is in milliseconds.
- Restart Business Process Manager to activate the change.

## Detaching volumes

If necessary, you can unmount and detach a volume.

This use case is available as an instance action applicable to a volume resource instance. The volume instance must be in in-use status.

If the volume has been previously formatted, its filesystem persistent data, such as type, label, and UUID are not deleted from the metadata.

To run this scenario, perform the following steps:

1. Go to the volume resource view by clicking the **RESOURCES** tab and then clicking the **Volumes** icon.
2. Select an in-use volume.
3. Click the **Detach volume** action.
4. If your volume is mounted, specify how you want to connect to the machine. See the options in “Attaching volumes” on page 66.
5. Check the summary and click **Submit**.

Table 57. Configuration

<b>Name</b>	Detach volume
<b>Instance type</b>	volumes
<b>Process</b>	Detach Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)
<b>User interface</b>	Detach Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)

## Deleting volumes

You can delete one or more volumes that are in available status.

This use case is available as an instance action applicable to a volume resource instance. The volume instance must be in available status.

To run this scenario, perform the following steps:

1. Go to the volume resource view by clicking the **RESOURCES** tab and then clicking the **Volumes** icon.
2. Select one or more available volumes.
3. Click the **Delete volume** action.
4. Confirm the action.

Table 58. Configuration

<b>Name</b>	Delete volume
<b>Instance type</b>	volumes
<b>Process</b>	Delete Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)

## Managing volumes related to a virtual system instance

You can attach or delete all the available volumes that are defined in the project that you are currently logged on to. You can detach the volumes in the same project that are in use by the selected virtual system instance.

This use case is available as instance action applicable to an **openstackvms** resource instance.

To run this scenario, perform the following steps:

1. Go to the **RESOURCES** tab and click the **VMs** icon.
2. Select a virtual machine.
3. Click the **Manage volume** action.
4. Select a volume from the ones that are created in the project that you are currently logged on to and in the region where your instance is hosted. When you select a volume, the action buttons are enabled or disabled depending on the status of the selected volume. If the volume is available, you can attach it to a virtual machine or delete it. If the volume is in use, you can detach it from its virtual machine.
5. Click the management action that you want to perform on the selected volume:

### Attach

Select the virtual machine where you want to attach the volume. Choose whether to format and mount the volume. You cannot enable this option on machines that are powered off. If you chose to format and mount the volume, select operating system type, file system type, mount point, and configure the access to the machine. See “Attaching volumes” on page 66. After reviewing the summary, click **Submit**. The volume is attached, formatted, and mounted to the selected machine.

**Note:** For Linux operating systems, if you chose to mount the file system on which you have formatted the volume, no record in the `/etc/fstab` file is added. When you restart the machine, the file system is no longer mounted and you must mount it manually.

### Detach

If the volume is mounted, you must configure access to the virtual machine to unmount it before detachment. Review the summary and click **Submit**. The volume is detached from the attached virtual machine.

### Delete

Review the summary and click **Submit**. The volume is deleted and no longer appears in the volume list.

**Note:** Only volumes that are in "available" state or attached to the selected Virtual System instance are listed in the volume table.

Table 59. Configuration

<b>Name</b>	Manage volume
<b>Instance type</b>	<b>openstackvms</b>
<b>Process</b>	Manage Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)
<b>User interface</b>	Manage Volumes (SCOrchestrator_OpenstackBlockStorage_Toolkit)

---

## Toolkit developer's reference

This section contains reference information about the Business Process Manager artifacts exposed in the toolkit contained in the content pack. It is intended to be used by IBM Cloud Orchestrator content developers to extend the already available scenarios or to write new scenarios leveraging the building blocks available from the toolkit.

The `SCOrchestartor_OpenstackBlockStorage_Toolkit` has dependencies against the following toolkits:

- `SCOrchestrator_Support_vSys_Toolkit`
- `SCOrchestrator_Support_IaaS_Toolkit`
- `SCOrchestrator_Scripting_Utilities_Toolkit`
- `SCOrchestrator_Toolkit`
- `SCOrchestrator Nova Support Toolkit`

The following items are the main building blocks of the toolkit:

- “Environmental variables”
- “Business objects”
- “Human services” on page 71
- “Coach views” on page 71
- “Business processes” on page 72
- “Integration services” on page 73

### Environmental variables

Some environment variables are available so you can customize some behaviors when you run the use cases.

Environmental variables are defined in the toolkit in **Toolkit Settings > Environment**.

#### **ATTACH\_TIMEOUT**

This variable specifies the maximum time, in minutes, to wait for a volume becoming available after creation changing its status, for example from creating to available or from available to in-use.

### Business objects

There are Business Process Manager business objects defined in the toolkit.

#### **AttachVolumesToInstanceRequestData**

This business object is used for storing information about the volume which is being attached to a given instance.

#### **CinderBreadcrumbsObject**

This object is used for storing the temporary properties to manage the breadcrumb widget that appears on the bottom part of some user interfaces.

## **VMCredentials**

This object stores the virtual machine credentials and in case also public and private ssh keys.

## **Volume**

This is the volume object. It contains info about the volume name, status, volume type, ID, size, attachment metadata, and the server which it is attached to.

## **Volume\_Attachment**

This object stores the correspondence between the volume and the server it is attached to.

## **VolumeManager**

This object contains the volume data, the operation which must be carried out on this volume, the attachment data for this volume, the virtual machine object the volume must be attached to and the region which the volume is defined on.

## **Volume type**

This object represents the volume type or Storage Service Level.

## **Human services**

There are a number of Human Services artifacts available in the toolkit.

### **Attach Volumes**

This an entry point user interface for the "Attach volume" instance action.

### **Detach Volumes**

This an entry point user interface for the "Detach volume" instance action.

### **Create Volumes**

This an entry point user interface for the "Create volumes" self-service offering.

### **Manage Volumes**

This an entry point user interface for the "Manage volumes" instance action.

## **Coach views**

There are a number of coach view artifacts available in the toolkit.

### **Breadcrumbs**

It is the breadcrumb widget that appears on the bottom part of some user interfaces.

### **Generic Listener**

It is the panel fragment which show the summary for detaching operation.

## **Password**

The Password coach view renders the password as a masked input.

## **Server Selected Listener**

This is the listener on the servers list. It disables the **Next** button if no servers are selected.

## **Vertical Two RadioButtons**

A coach view for implementing a choice between two possibilities.

## **Volume Selected Listener**

This is the listener on the volumes list. It disables the buttons which correspond to action not compatible with the selected volume status. For example, volumes “in-use” can only be detached.

## **Business processes**

There are a number of the business processes available in the toolkit.

### **Attach Volume**

This process attaches a volume to a given virtual server and can, if necessary, format and mount it after the attachment. It returns the volume object after the attachment.

### **Attach Volume Utility**

A wrapper for the Attach Volume process which provides a more usable interface for input parameters.

### **Create Volume**

This process create a new volume of a given size within a given volume type on a specified region. The volume is returned as output value if it has been available after a given timeout.

### **Create Volume Utility**

A wrapper for the Create Volume process which provides a more usable interface for input parameters.

### **Create Volumes**

This process loops over the number of requested volumes calling Create Volume process for creating them.

### **Detach Volumes**

This process detaches a volume and, if it is mounted, unmounts it before detachment.

## **Delete Volume**

This process triggers a volume deletion and wait for it is completed.

## **Manage Volumes**

This process create a new volume or manage an existing volume as stated by an operationid (1=ATTACH, 2=DETACH, 3=DELETE). It is called by “Manage Volumes Offering” and “Manage Volumes Action” processes.

## **Integration services**

There are a number of integration services available in the toolkit.

### **Attach Volume Service**

This integration service attaches one or more Cinder Volumes to a given server.

### **Create Volume Service**

This integration service creates a volume.

### **Delete Volume**

This integration service deletes a volume.

### **Detach Volume**

This integration service detaches a volume from a server.

### **Format Volume on Linux**

This integration service connects to Linux machine, formats an attached volume, and mounts it to a given mount point. The volume is formatted as a single partition and mounted by using the script `configure_volume.sh` which is contained in the toolkit. It also updates the attachment metadata for the volume. The script is executed remotely via SSH by using the management IP address. The SSH connection is tried for each available machine IP until it is successful. The SSH connection can be carried out either by providing credentials or by using a pre-configured `privateKey`.

### **Format Volume on Windows**

This integration service connects to a Windows machine, formats an attached volume, and mounts it to a given mount point. The volume is formatted as a single partition and mounted by using the script `configure_volume.ps1` which is contained in the toolkit. It also updates the attachment metadata for the volume. The script is executed remotely via SMB by using the management IP address. The SMB connection is tried for each available machine IP until it is successful.

### **Get Message**

This integration service gets a message from the loaded message bundle.

## **Get Volume**

This integration service retrieves a volume given its ID.

## **Get Volume Attachment MetaData**

This integration service returns the volume attachment data (filesystem type, mount point, filesystem label, and file system UUID) by retrieving them from volume metadata.

## **List Volume Types**

This integration service retrieves all volume types defined on a given region.

## **List Volumes**

This integration service gets the list of all volumes defined on a given region.

## **Load Message Bundle**

This integration service loads the message bundles.

## **Set Volume Attachment Metadata**

This integration service sets the volume attachment metadata.

## **Set Volume Metadata**

This integration service set a volume metadata.

## **Unmount Attached Volume Partition**

This integration service connects to a Windows or Linux machine and unmounts the mounted volume. It also updates the attachment metadata for the volume. The script is executed remotely via SMB or SSH by using the management IP address. The SMB or SSH connection is tried for each available machine IP until it is successful. The SMB or SSH connection can be carried out either by providing credentials or by using a pre-configured privateKey (only for Linux).

## **Unset Volume Metadata**

This integration service deletes one volume metadata.

---

## **Samples about how to use the available services and views**

The services that are delivered as part of this content pack can be used as starting points and as samples for developing new content.

Using samples can give you an idea about how to invoke and combine the Integration Services delivered in the content pack. You can clone and adapt them to better fit your needs. Once you are familiar with them, you can start creating your new offerings and actions.

For information about how to develop new content, see [Developing IBM Cloud Orchestrator content](#).

---

## Importing XML into IBM Cloud Orchestrator

Refer to this sample XML file that you can use, with the Self-Service Catalog Population tool, to create all the offerings and instance actions required to leverage the capabilities provided by this content pack in IBM Cloud Orchestrator.

```
<?xml version="1.0" encoding="UTF-8"?>
<catalog version="2.4">
  <automation-categories>
    <category>
      <name>Deploy cloud services</name>
      <description>A set of offerings to manage the life cycle of
        cloud services</description>
      <icon>Storage</icon>
    </category>
  </automation-categories>

  <offerings>
    <offering>
      <name>Create volumes</name>
      <description>This offering allows you to create a volume
        to be used in a domain--> project.</description>
      <icon>Storage</icon>
      <category-name>Deploy cloud services</category-name>
      <process>
        <name>Create Volumes</name>
      </process>
      <user-interface>
        <name>Create Volumes</name>
      </user-interface>
    </offering>
  </offerings>

  <instance-actions>

    <instance-action selection-type="multiple">
      <name>Delete volumes</name>
      <description>This action applies to available volumes in the project.
        Selected volumes are to be deleted.</description>
      <icon>Storage</icon>
      <instance-type>volumes</instance-type>
      <process>
        <name>Delete Volume</name>
      </process>
      <tags>
        <tag>cinder</tag>
        <tag>available</tag>
      </tags>
    </instance-action>

    <instance-action selection-type="single">
      <name>Detach volume</name>
      <description>This action applies to volumes attached to virtual
        servers and enables you to detach the volumes from the
        virtual servers they are attached to.</description>
      <icon>Detach</icon>
      <instance-type>volumes</instance-type>
      <process>
        <name>Detach Volumes</name>
      </process>
      <user-interface>
        <name>Detach Volumes</name>
      </user-interface>
      <tags>
        <tag>cinder</tag>
        <tag>in-use</tag>
      </tags>
    </instance-action>
  </instance-actions>
</catalog>
```

```

</instance-action>

<instance-action selection-type="single">
  <name>Attach volume</name>
  <description>This action applies to volumes not attached to virtual
    servers and enables you to attach the volumes to a virtual server
    defined in the same project.</description>
  <icon>Storage</icon>
  <instance-type>volumes</instance-type>
  <process>
    <name>Attach Volume</name>
  </process>
  <user-interface>
    <name>Attach Volume</name>
  </user-interface>
  <tags>
    <tag>cinder</tag>
    <tag>available</tag>
  </tags>
</instance-action>

<instance-action selection-type="single">
  <name>Manage volume</name>
  <description>This action enables you to manage the volumes of a virtual server.
    It provides a single view of the status of the volumes attached to the
    virtual server and enables you to manage existing volumes and create
    new ones on behalf of the virtual server.</description>
  <icon>Storage</icon>
  <instance-type>openstackvms</instance-type>
  <process>
    <name>Manage Volumes</name>
  </process>
  <user-interface>
    <name>Manage Volumes</name>
  </user-interface>
  <tags>
    <tag>nova</tag>
  </tags>
</instance-action>

</instance-actions>

</catalog>

```

---

## Troubleshooting

There are some known problems and limitations.

- For non-IBM supplied OpenStack, because formatting volumes is not supported, the **Attach volumes** action is supported only if the **Format volume** option is not selected.

### Logs and traces

If you receive an error, you can check the Business Process Manager log files SystemOut.log and SystemErr.log at /opt/ibm/ico/BPM/v8.5/profiles/Node1Profile/logs/SingleClusterMember1/.

You can find extra logs on the OpenStack Controller at /var/log/cinder and /var/log/nova. For errors regarding format and mount operation, a log file formatFileSystem.log is present in the /tmp directory of the virtual machine. Error messages are logged for all probable errors during deployment.

## Error codes

Table 60. Error codes

Error code	Cause
CTJCA2000E	The volume was not available within the defined timeout. See <i>ATTACH_TIMEOUT</i> variable. Its status might be <i>creating</i> or <i>error</i> .
CTJCA2001E	A problem occurred while trying to format and mount the attached volume. This is usually due to a connection problem.
CTJCA2002E	A problem occurred while trying to to unmount the attached volume. This is usually due to a connection problem.
CTJCA2006E	A problem occurred in updating metadata of the volume.



---

## Appendix F. OpenStack Services toolkit

The `SCOorchestrator_OpenStack_Services` toolkit is delivered with IBM Cloud Orchestrator. It provides offerings to deploy a predefined Linux or Windows virtual machine, or to deploy a multitiered LAMP stack (Linux and Apache, Linux and MySQL, Linux and PHP).

These offerings refer to operating system images that are not distributed with IBM Cloud Orchestrator. Before using the offerings, you must perform the configuration steps described in “Configuring.”

---

### Configuring

Before using the offerings provided in the OpenStack Services toolkit, you must perform the following configuration steps.

- “Defining a Linux image”
- “Defining a Windows image”
- “Configuring an SMTP server” on page 80

#### Defining a Linux image

Before deploying a Linux virtual machine, you must create a Linux image, add it to your OpenStack environment, and create a key pair for accessing the virtual machine. Perform the following steps:

1. Create a Linux image by following the procedure described in Creating Linux base images. Alternatively, for example, you can download a CentOS image from [http://cloud.centos.org/centos/6/images/CentOS-6-x86\\_64-GenericCloud.qcow2](http://cloud.centos.org/centos/6/images/CentOS-6-x86_64-GenericCloud.qcow2).
2. Add the image to your OpenStack environment by following the procedure described in Adding images to your OpenStack environment.

**Important:** You must specify `linux_img` as name of the image.

3. Create a key pair for accessing the Linux virtual machine by following the procedure described in Registering a key pair.

**Important:** You must specify `linux_key` as name of the key pair.

#### Defining a Windows image

Before deploying a Windows virtual machine, you must create a Windows image and add it to your OpenStack environment. Perform the following steps:

1. Create a Windows image by following the procedure described in Creating Windows base images.
2. Add the image to your OpenStack environment by following the procedure described in Adding images to your OpenStack environment.

**Important:** You must specify `windows_img` as name of the image.

## Configuring an SMTP server

To use the email notification feature, you must configure Business Process Manager to use an appropriate SMTP relay server inside your organization. Contact your mail server administration team to obtain the host name of the SMTP server.

Business Process Manager does not support any type of SMTP authentication or non standard SMTP ports.

Perform the following steps:

1. Create a file that is called 100Custom.xml with the following content:

```
properties>
  <server merge="mergeChildren">
    <email merge="mergeChildren">
      <smtp-server merge="replace">${SMTP_HOST_NAME}</smtp-server>
    </email>
  </server>
</properties>
```

2. Replace `SMTP_HOST_NAME` with your SMTP server host name.
3. Put the 100Custom.xml file in the directory `/opt/ibm/ico/BPM/v8.5/profiles/DmgrProfile/config/cells/PCCell1/nodes/Node1/servers/SingleClusterMember1/process-center/config`. If the file already exists, edit it adding or updating the server and email sections with the provided information.
4. Restart the Business Process Manager server by using the following command:  
`service bpm restart`

---

## Toolkit scenarios

There are a number of scenarios that are available from the toolkit.

Before running the scenarios, ensure you performed the configuration steps described in “Configuring” on page 79

The following scenarios are available:

- “Deploying a Linux virtual machine”
- “Deploying a Linux virtual machine with approval and notification” on page 81
- “Deploying a Windows virtual machine” on page 82
- “Deploying a LAMP stack using multitiered technology” on page 82

## Deploying a Linux virtual machine

To deploy a Linux virtual machine, perform the following procedure.

### Before you begin

Ensure you have a Linux image and key pair defined as described in “Defining a Linux image” on page 79.

### Procedure

1. In the Self-service user interface, click **SELF-SERVICE CATALOG** and open the **Deploy customized cloud services** category.
2. Click the **Deploy single Linux server** offering.

## Results

A new virtual machine named `Sample Linux Server_n` (where  $n$  is the number of deployments done) is created with medium flavor.

To get the virtual machine details, click the `Sample Linux Server_n` name in the list that you can access from **RESOURCES > Virtual Machines**.

To access the virtual machine, use the `linux_key` key pair that was created in the procedure described in “Defining a Linux image” on page 79.

## Deploying a Linux virtual machine with approval and notification

To deploy a Linux virtual machine with an approval process and a notification email, perform the following procedure.

### Before you begin

Ensure you have a Linux image and key pair defined as described in “Defining a Linux image” on page 79.

Ensure an email address is configured in IBM Cloud Orchestrator for the user that is running the offering.

Ensure an SMTP server is configured as described in “Configuring an SMTP server” on page 80.

### Procedure

1. In the Self-service user interface, click **SELF-SERVICE CATALOG** and open the **Deploy customized cloud services** category.
2. Click the **Deploy single Linux server with approval and notification** offering. A request to create a Linux virtual machine is created. The admin user must claim and approve this request. When the request is approved, you receive an email to the address configured for your user.

## Results

A new virtual machine named `Sample Linux Server_n` (where  $n$  is the number of deployments done) is created with medium flavor.

To get the virtual machine details, click the `Sample Linux Server_n` name in the list that you can access from **RESOURCES > Virtual Machines**.

To access the virtual machine, use the `linux_key` key pair that was created in the procedure described in “Defining a Linux image” on page 79.

## Deploying a Windows virtual machine

To deploy a Windows virtual machine, perform the following procedure.

### Before you begin

Ensure you defined a Windows virtual machine as described in “Defining a Windows image” on page 79.

### Procedure

1. In the Self-service user interface, click **SELF-SERVICE CATALOG** and open the **Deploy customized cloud services** category.
2. Click the **Deploy single Windows server** offering.

### Results

A new virtual machine named Sample Windows Server is created with medium flavor.

To get the virtual machine details, click the Sample Windows Server name in the list that you can access from **RESOURCES > Virtual Machines**.

To access the virtual machine, use admin and Passw0rd as credentials.

## Deploying a LAMP stack using multitiered technology

To deploy a LAMP stack with multiple virtual machines and on each virtual machine deploying the specific software for that tier (Apache, MySQL, PHP), perform the following procedure.

### Before you begin

Ensure you have a Linux image and key pair configured as described in “Defining a Linux image” on page 79.

Ensure the availability of the following packages:

- Apache
- MySQL
- PHP

### Procedure

1. In the Self-service user interface, click **SELF-SERVICE CATALOG** and open the **Deploy customized cloud services** category.
2. Click the **Deploy LAMP stack** offering.

### Results

A LAMP stack is created with three new virtual machine instances with medium flavor.

To get the stack details, click the stack instance name in the list that you can access from **RESOURCES > Stacks**. To get details on the virtual machine instances, click on each server resource.

To access the virtual machine instances, use the `linux_key` key pair that was created in the procedure described in “Defining a Linux image” on page 79.



---

## Accessibility features for IBM Cloud Orchestrator

Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use software products successfully. The major accessibility features of IBM Cloud Orchestrator are described in this topic.

### Accessibility features

The following list includes the major accessibility features in IBM Cloud Orchestrator:

- Keyboard-only operation
- Interfaces that are commonly used by screen readers
- Keys that are discernible by touch but do not activate just by touching them
- Industry-standard devices for ports and connectors
- The attachment of alternative input and output devices

**Note:** The default configuration of JAWS screen reader does not read tooltips. JAWS users must enable their current mode to read tooltips by selecting **Utilities > Settings Center > Speech Verbosity > Verbosity Level > Configure Verbosity Levels**.

User documentation is provided in HTML and PDF format. Descriptive text is provided for all documentation images.

The knowledge center, and its related publications, are accessibility-enabled.

### Related accessibility information

You can view the publications for IBM Cloud Orchestrator in Adobe Portable Document Format (PDF) using the Adobe Reader. PDF versions of the documentation are available in the knowledge center.

### IBM and accessibility

See the IBM Human Ability and Accessibility Center for more information about the commitment that IBM has to accessibility.



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## Programming interface information

This publication primarily documents information that is NOT intended to be used as Programming Interfaces of IBM Cloud Orchestrator. This publication also documents intended Programming Interfaces that allow the customer to write programs to obtain the services of IBM Cloud Orchestrator. This information is identified where it occurs, either by an introductory statement to a chapter or section or by the following marking: *Programming Interface information*.

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---

## Glossary

This glossary includes terms and definitions for IBM Cloud Orchestrator.

The following cross-references are used in this glossary:

- See refers you from a term to a preferred synonym, or from an acronym or abbreviation to the defined full form.
- See also refers you to a related or contrasting term.

To view glossaries for other IBM products, go to [www.ibm.com/software/globalization/terminology](http://www.ibm.com/software/globalization/terminology) (opens in new window).

---

### A

#### **account code**

A code that uniquely identifies an individual, billing, or reporting entity within chargeback and resource accounting.

#### **account code conversion table**

An ASCII text file that contains the definitions that are required to convert the identifier values defined by the account code input field to the user-defined output account codes.

#### **account report**

A report that is used to show account level information for usage and charge.

#### **availability zone**

A logical group of OpenStack Compute hosts. It provides a form of physical isolation and redundancy from other availability zones, such as by using separate power supply or network equipment.

---

## B

### building block

The model of an image that is created by combining models of a base operating system and software bundles. Each building block contains a semantic and functional model that describes the contents of the components, for example, the installed products, supported operating systems, prerequisites, and requirements.

### business object

A software entity that represents a business entity, such as an invoice. A business object includes persistent and nonpersistent attributes, actions that can be performed on the business object, and rules that the business object is governed by.

### business process

A defined set of business activities that represent the required steps to achieve a business objective. A business process includes the flow and use of information and resources.

---

## C

### chargeback identifier

A label, which is often tied to an algorithm or set of rules, that is not guaranteed to be unique, but is used to identify and distinguish a specific chargeback item or chargeback entity from others.

### compute node

A node that runs a virtual machine instance, which provides a wide range of services, such as providing a development environment or performing analytics.

### consolidation process

A process during which the data collectors process the nightly accounting and storage files that were created by the data collection scripts and produce an output CSR file.

### conversion mapping

An entry in a mapping table which allows you to map identifiers to accounts or other identifiers.

### custom node

A virtual image part that provides an

unconfigured node for a pattern that has a deployment manager or a control node as its base.

---

## E

### exception file

A file that contains a list of records with identifier names that do not have a matching Parameter IdentifierName attribute value.

### exception processing

A process in which the system writes all records that do not match an entry in the account code conversion table to an exception file.

---

## H

### human service

An activity in the business process definition that creates an interactive task that the process participants can perform in a web-based user interface.

### hypervisor

Software or a physical device that enables multiple instances of operating systems to run simultaneously on the same hardware.

---

## K

**kernel** The part of an operating system that contains programs for such tasks as input/output, management and control of hardware, and the scheduling of user tasks.

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## P

### parameter (parm)

A value or reference passed to a function, command, or program that serves as input or controls actions. The value is supplied by a user or by another program or process.

**parm** See parameter.

### performance counter

A utility that provides a way for software to monitor and measure processor performance.

**primary key**

In a relational database, a key that uniquely identifies one row of a database table.

**process application**

A container in the Process Center repository for process models and supporting implementations. A process application typically includes business process definitions (BPDs), the services to handle implementation of activities and integration with other systems, and any other items that are required to run the processes. Each process application can include one or more tracks.

**proration**

A process that distributes the overall or individual resources of an account and the cost of those resources across multiple accounts at a specified percentage.

**proration table**

An ASCII text file that defines the identifier values and rate codes that are used in the proration process.

configuration files, and metadata that can be deployed on a virtual machine instance.

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**T****toolkit**

A container where artifacts can be stored for reuse by process applications or other toolkits.

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**R****rate code**

The identifier of a rate that is used to link a resource unit or volume metric with its charging characteristics.

**rate group**

A group of rate codes that is used to create rate subtotals in reports, graphs, and spreadsheets.

**registry**

A repository that contains access and configuration information for users, systems, and software.

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**S****service operation**

A custom operation that can be run in the context of the data center. These operations are typically administrative operations and are used to automate the configuration. Service operations can also be used to enhance the catalog of available services with extra functionality.

**software bundle**

A collection of software installation files,

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## V

### **virtual machine (VM)**

An instance of a data-processing system that appears to be at the exclusive disposal of a single user, but whose

functions are accomplished by sharing the resources of a physical data-processing system.

**VM** See virtual machine.





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