Benefits of running OpenShift workloads on IBM Z
The data challenge
Enterprises are seeing an enormous amount of growth in data and transaction volumes being generated and transmitted across private, public and hybrid cloud environments. Applications, through which this data is generated and transmitted, need to manage this data optimally without compromising performance or scale.

Proliferation of data can make meeting agreed upon service level agreements (SLAs) a challenge. When SLA’s are not met, enterprises can face penalties resulting in incremental costs. Missed SLAs can also lead to a decline in end user application usage, which can lead to lost revenue opportunity.

In addition to growing networking requirements for the transfer of more and more data, infrastructures running these applications need to be scalable to manage spikes in traffic, resilient to provide high availability and fault tolerance, secure from inside or outside attacks and cost-effective, all while keeping complexity in check.

In this paper, we examine how enterprises can address these challenges by using Red Hat® OpenShift® running on IBM Z®. IBM tests show that the same OLTP workloads on OpenShift require less compute resources on Linux® on an IBM z15™ T01 and deliver a 37% lower TCO over three years than compared x86 servers.1 IBM Z provides enterprise proven scalability, resiliency and security for both small and large businesses, with cost efficiencies through workload consolidation.

How colocation helps
Colocation is an application deployment methodology in which all the layers of a multi-tier application (web, application and database) are run on the same physical system. This type of deployment optimizes internal communications across all application layers which in turn can lower resource utilization for network processing, enable higher throughput and reduce latency with lower response times. A single physical system that contains all layers of the application benefits from local access to a single shared resource pool, seamless scalability and elasticity, and fewer points of entry to protect the data.

1 This is an IBM internal study designed to replicate banking OLTP workload usage in the marketplace on an IBM z15 T01 using eight IFLs across three LPARs. Three IFLs and a total of 512 GB memory were allocated to one LPAR for two OpenShift masters and two worker nodes. Another four IFLs and a total of 512 GB memory were allocated to a second LPAR for one OpenShift master and two workers. One IFL and a total of 128 GB memory were allocated to a third LPAR for the OpenShift load balancer. IBM Storage DS8886 was used to create eight 250 GB DASD minidisks for each of the eight z/VM guests running in the LPARs. The OpenShift cluster version 4.2.20, using Red Hat Enterprise Linux CoreOS (RHCOS) for IBM Z, was running across seven z/VM guests and the remaining eighth z/VM guest was running the OpenShift load balancer. SMT was enabled across all IFLs. The x86 configuration was comprised of six servers running KVM with 12 guests (three masters and twelve workers) for the OpenShift cluster version 4.3.5 with RHCOS and a seventh server was used for the load balancer on RHEL 7.6. For x86 storage each guest operating system was configured with a 100 GB of virtual disk. Each guest had access to all vCPUs of the KVM server on which it was running. Compared x86 models for the cluster were all 2-socket servers containing a mix of 6-core, 8-core, 12-core and 16-core Haswell, Skylake and Ivy Bridge x86 processors using a total of 136 cores with a total of 2,304 GB memory, resulting in 17x more cores than used by IBM Z. The load balancer was a 2-socket 8-core server with a total of 384 GB memory. Both environments used JMeter to drive maximum throughput against two OLTP workload instances and were sized to deliver comparable results (15,456 responses per second (RPS) with IBM Z and 14,848 RPS with x86). The results were obtained under laboratory conditions, not in an actual customer environment. IBM’s internal workload studies are not benchmark applications. Prices, where applicable, are based on U.S. prices as of 02/12/2020 from our website and x86 hardware pricing is based on IBM analysis of U.S. prices as of 03/01/2020 from IDC. Price comparison is based on a three year total cost of ownership including HW, SW, networking, floor space, people, energy/cooling costs and three years of service & support.
Colocating workloads on IBM Z

Colocating workloads on IBM Z can provide a significant advantage over an environment comprised of x86 servers. IBM Z offers optimized internal networking through shared Open Systems Adapter (OSA) adapters as depicted in figure 1. A single OSA card can be shared across several logical partitions in a single IBM Z system, causing all communication between the partitions to occur within the system. By remaining within the physical system, communications across all application tiers can bypass external network switches, firewalls and gateways in the data center. Colocation on IBM Z consolidates the application, data and system resources to a single shared environment, avoiding latency across the network and accelerating response times.

When compared to networking in an x86 server environment as depicted in figure 2, communications can take longer with multiple network hops from network switches and firewalls. This increases the path length for application requests and responses, resulting in greater networking compute resources that can cause latency and poor application performance. Moreover, these switches can be costly, driving up overall costs for an x86 environment.
Other benefits of IBM Z

Application and data colocation in an IBM Z environment not only accelerate response time and application performance. An IBM Z environment also provides enterprise level capabilities for mission critical hybrid multicloud solutions. The following features available with IBM z15 enable businesses to move forward on their journey to the cloud by providing workload modernization via microservices, or lift and shift of workloads to Linux on IBM Z, for private, hybrid and multicloud environments. IBM z15 enables:

- Open standards support for operating systems, middleware, storage and security
- Flexible infrastructure to concurrently accommodate a wide range of operating systems and applications, from traditional z/OS workloads such as CICS, COBOL with z/VM to the world of Linux, cloud, analytics and mobile computing
- Highly scalable across single and multiple central processor complex (CPC) systems supporting vertical and horizontal growth for applications and databases non-disruptively
- High Performance Computing (high processor frequency, large high-speed buffers (cache) and memory, high-bandwidth channels, and enhanced superscalar processor technology)
- Hybrid and multicloud readiness (OpenShift support, IBM Z Container Extensions running in z/OS address space, zEnterprise Data Compression for faster data transfer and encrypt – decrypt data, IBM Multi-Cloud Management support)
- Secure Execution (LPARs created using PR/SM that is EAL 5+ certified) and Secure Boot (validates Linux kernel on Initial Program Load)
- Resiliency, accessibility and serviceability and fault tolerance
- System Recovery Boost for planned and unplanned outages Data privacy and security (pervasive encryption), chip level cryptography (CP Assist for Cryptographic Function), and crypto express adapters that meet industry compliance standards
- High availability through core sparing in all system sizes
- Efficient data transfer through HiperSockets™, Shared Memory Communications-Direct Memory Access (SMC-D) and Shared Memory Communications-Remote Direct Memory Access (SMC-R across multiple CPCs)
- Self-managing and self-optimizing to adapt to changing workload needs while delivering best performance and meeting service level agreements

OpenShift – An enterprise container platform

Red Hat OpenShift is an enterprise-ready container platform based on open source Kubernetes container orchestration with full-stack automated operations to manage hybrid and multicloud deployments. Some of the key differentiators of OpenShift over alternative container technologies are:

- Built on open source, enabling applications to run across physical, virtual, private, public or hybrid cloud infrastructures without vendor lock-in

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3 What is OpenShift, https://www.openshift.com/learn/what-is-openshift
• Includes enterprise grade Linux operating system, container runtime, networking, monitoring, registry and authentication and authorization solutions
• Increases productivity with streamlined developer workflows for agile application delivery
• Designed to be administrator friendly for day 2 operations such as cluster upgrades, and OS patching through automated maintenance
• Advanced capabilities such as Service Mesh which provides a uniform way to connect, manage and observe microservices-based applications, Knative for serverless application development, deployment and management, Cloud Native Pipelines for continuous integration and continuous deployment (CI/CD).

How OpenShift workloads on IBM Z compare to x86
To examine how OpenShift workloads on IBM Z compare to running on x86, we used an OLTP banking microservices application to simulate a real customer workload. Testing measured the number of compute resources needed to deliver a similar number of transactions per second at a fixed SLA response time for a fixed workload of virtual application users on both x86 and IBM z15 using the following parameters.

• Banking microservices fixed workload: 400 virtual application users
• Banking microservice requests fixed SLA response time: 64 milliseconds
• Similar Transactions Per Second using 400 users

Test environment for x86
Figure 3 depicts the OpenShift Container Platform (OCP) 4.2 on x86 servers set up. A total of seven x86 servers were used with RHEL KVM hypervisor running on six of the servers and the remaining seventh server was running the HA Proxy load balancer on RHEL.
15 VMs were configured using KVM on six servers for three OpenShift master nodes and 12 OpenShift worker nodes. The banking application microservices packaged in WebSphere® Liberty server were deployed as Kubernetes pods across all the worker nodes and scaled to two instances. All application microservices interacted with Db2® on z/OS for reads, writes and updates. A total of 136 cores from seven x86 servers were needed to deliver a throughput similar to what z15 delivered to meet a fixed SLA of 64 milliseconds and 400 virtual users load.

Test environment on IBM z15
Figure 4 depicts the OpenShift Container Platform (OCP) 4.2 on z15 set up. A total of eight Integrated Facility for Linux (IFLs) with SMT2 were allocated across three logical partitions, each running in a z/VM hypervisor.

8 VMs were configured using z/VM across three logical partitions with one VM running the HA Proxy load balancer. Three VMs ran OCP master nodes and four VMs ran OCP worker nodes. The banking application microservices packaged in WebSphere Liberty server were deployed as Kubernetes pods across all the worker nodes and scaled to two instances. All services interact with Db2 on z/OS for reads, writes and updates. A total of eight z15 T01 IFLs were needed to deliver a throughput similar to what the x86 set up delivered using a fixed SLA of 64 milliseconds and 400 virtual users load.

Note: OpenShift 4.2 on IBM Z is supported on IBM z13®, LinuxONE systems and newer models.
**Findings**

Testing found that the OLTP workload on OpenShift in IBM z15 environment could deliver the same transactions per second and response time as the OpenShift x86 environment\(^1\) with fewer resources. The performance advantage on z15 is primarily due to the colocation of all the application tiers (OCP load balancer, OCP workers running the application services and the application database) running on one physical system. Running all the application services inside one physical system reduced latencies and improved performance. In contrast, the x86 environment entailed numerous network hops resulting from the use of seven separate servers.

In addition to measuring performance and core consolidation on each platform, an estimated total cost of ownership (TCO) was calculated for each environment. The TCO model included hardware, system software, application software, people, networking, floor space, and energy and cooling. Costs were calculated over a three-year period and assumed production systems only.

The TCO comparison showed that z15 had a 37% lower TCO versus the compared x86 environment for the banking OLTP application (shown in chart 1). A significant factor in the model for the x86 TCO was the estimated cost of software. Even with z/VM virtualization costs included in the z15 case, and zero KVM virtualization costs included in the x86 case (KVM is available at no-charge with RHEL), x86 software costs for Red Hat OpenShift and IBM WebSphere were considerably higher for the x86 case due to the number of cores using the software. With 17x more x86 cores than IBM Z (136 x86 cores versus eight IBM Z IFLs)\(^1\), software costs for x86 over three years were 60%\(^4\) more than on z15 as a result of per core software pricing.

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\(^1\) IBM Z software was estimated to total $0.4M over three years resulting in a 60% savings compared to the estimated $1M for the x86 environment. Costs include license and support for virtualization, system software, IBM WebSphere and Red Hat OpenShift software.
Mitigate data challenges with OpenShift

As organizations manage more and more data in their cloud applications, application infrastructure has become an important consideration to optimize application performance and mitigate cost. OpenShift on IBM Z facilitates management of increasing data volumes by providing a cost-effective and hybrid cloud ready platform.

If your organization is evaluating OpenShift for the journey to modernization and digital transformation, consider using IBM Z for a secure, resilient and scalable platform. Contact the IBM IT Economics team at IT.Economics@us.ibm.com for more information on OpenShift on IBM Z. Ask for a no-charge hybrid cloud assessment to determine the most effective infrastructure for your data and cloud based solutions.

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