Speed to Market with Open Source

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Delivering new services to your clients quickly and frequently

Today, the DevOps approach is in common use to build, test, and deploy applications and services in rapid cycles that are aimed at delivering continuous, incremental improvements. However, this fast-paced approach is putting new demands on the IT infrastructure, especially the platform. To be effective, DevOps requires a highly virtualized environment that provides developers, testers and deployers with the resources at their finger tips. The software tooling must be simple to use and effective, and there must be an operational layer of tools to deploy applications and to manage multiple secure environments. The IT platform must provide:

- Immediate provisioning of build, test and deploy environments
- High levels of integrated hardware and software virtualization to meet fluctuating demands
- Application and service portability
- Shorter paths to resources for improved performance
- A consistent securable method of protecting resources and data
- Resource management to share components across the entire service lifecycle
- The ability to analyze data in real-time

Also, enterprises have been utilizing cloud technologies to deliver new cloud native services at scale and at lower cost, but often there is the risk of vendor lock-in and escalating costs. About 80 percent of enterprise applications and services have not yet moved to the cloud due to concerns with security, connectivity, and management across clouds.

To help offset the needs associated with delivering applications and services more often and faster, the correct blending and balance of open source technologies, ISV tools, and the IT platform in which they run is key.

Over the past decade, IBM has created an ecosystem of clients, business partners, and ISVs who are engaging in an open source development community to bring the most important and most sought-after foundational open source technologies to its IT platforms. IBM is a member of many open-standard organizations and software governance consortia that help to shape the future of open source software.
Open source and platform blending

The complementary blending of a robust and securable hardware platform with the power of a Linux distribution can optimize modern applications and is positioned to accommodate scale-out clusters and scalable clouds. This includes access to a wide range of software and packages to provide the appropriate tooling for the build, test, and deploy environments.

IBM LinuxONE™ is a platform that is designed for open source software. It provides both upward and outward scaling, unparalleled levels of virtualization, and a large number of processor units, including specialized processors for cryptography, I/O, and performance related functions.

Blending a Linux distribution with LinuxONE can provide the following benefits:

- Speed to market
- Automated management and control of services
- Security layers to protect firmware, software, and data
- Availability, performance, and scalability of environments

Many businesses and organizations are also looking to move past the basic cloud model and start the next chapter of their cloud transformation. The path forward is a modular cloud solutions approach, called containers. Containers make integration and modernization far easier and quicker by isolating pieces of software so they can run independently. As such, IBM® has introduced Cloud Paks that deliver enterprise software and open source components in open and secure solutions that are easily consumable and can run anywhere, including on LinuxONE.

IBM Cloud™ Paks deliver:

- Containerized IBM middleware, open source components, and a powerful solution for orchestrating and managing containers across multiple clouds
- Consistent added capabilities for deployment, lifecycle management, and production quality of service logging, monitoring, version upgrade and roll-back, vulnerability assessment and testing
- Certification by IBM to run on IBM Cloud Private (ICP) and IBM Cloud Kubernetes Service (IKS), providing full software stack support, and regular security, compliance and version compatibility updates by IBM

Currently, the Paks include:

- IBM Cloud Pak for Applications
- IBM Cloud Pak for Data
- IBM Cloud Pak for Integration
- IBM Cloud Pak for Multicloud Management
- IBM Cloud Pak for Automation

Developers can access the virtual environments they need to build, test and deploy their applications. Each virtual environment can be provisioned to meet specific needs as illustrated in Figure 1 on page 3.
Speed to market with LinuxONE and Linux

Businesses and organizations now require a broad range of services to meet the opportunities that are made possible through digital devices and open source applications to provide important services to customers, partners, and employees. The delivery time is crucial as arriving in second is not an option in a rapidly changing market of consumer expectations.

LinuxONE with a Linux distribution can supply enablers to open new opportunities, such as:

- Fast provisioning of virtual machines and on premises cloud environments for:
  - Agile single and parallel development containers
  - Multiple testing containers
  - Pre-production operational quality check
  - User training containers
  - Operational integration
  - Customer support
  - Test driving new technologies

- API exploitation:
  - Easy to consume APIs
  - Full conversant with REST APIs

- Choice of integrated tooling:
  - Open source tooling is available across the build, test, and deploy environments

Open source service orchestration

The speed and agility of resource provisioning is key to efficient DevOps. Projects that suffer delays waiting for hardware acquisition, software tooling, or set up of resources are not an option. These types of delays are unacceptable when enforcing agile iterations. Virtual machines and clouds must be readily available, modifiable, when projects are to deliver at speed to market.

A diverse and growing ecosystem enables developers to choose from a broad collection of tools to build applications and solutions and be confident the physical platform will support their choice of tools.
Deploying software workloads in a variety of configurations involves collecting or creating large numbers of disparate components, including the workload container images, configuration files, and data for integrating with your chosen platforms or management tools.

Containers provide the ability to run multiple software components, isolated from each other, and within the same operating system instance. Unlike a virtual machine, a container shares the operating system kernel with its underlying host, system calls can be made directly, hence a container runs more efficiently and can be instantiated faster.

As containers are lightweight and start quickly, makes them ideal for hosting microservices, which are a key element of cloud native application architectures. Traditional monolithic applications can also run inside containers, but benefit less from this technology. Consistently, remember that poorly architected and designed applications are still poorly architected and designed applications when run in a container. Although containers alone do not provide a framework for implementing production grade qualities of service such as resilience, scalability or maintenance.

Kubernetes is an open source orchestration platform for containers which provides solutions for these administrative challenges by providing a declarative framework for deploying, scaling, and managing container based workloads. It is a popular choice for managing clusters of containers throughout the industry.

IBM offers Kubernetes for customer managed environments as part of IBM Cloud Private and as a managed service in the public cloud by way of the IBM Cloud Kubernetes Service.

**Continuous delivery for DevOps on IBM Cloud Private**

The fast moving world of open source brings new applications and APIs daily. The challenge is to capture new and relevant offerings but to maintain the integrity and security of applications, APIs, and data at the same time. IBM Cloud Private is frequently updated to keep pace with the fast moving open source community and potentially to offer further possibilities for optimizing development practices and service deployment.

**Quality of service**

Fast development and high performance require both the software and the platform to be available. Strong virtualization is the key to providing and sustaining the availability of robust production environments and ever-changing development environments. The open source software must complement the platform’s capabilities to achieve the demands on availability, scalability, and performance. LinuxONE is designed to accommodate all of these aspects.

**High availability**

High availability cannot be achieved without a resilient IT platform. Every critical component must have resiliency built in to avoid single points of failure. IBM LinuxONE leads the industry in IT resiliency by providing technologies that avoid downtime, ensure access to critical applications and data, and maintain productivity of users.

The IBM LinuxONE platform is known for its reliability, availability, and serviceability (RAS) capabilities. RAS is built into the hardware and software stacks of the architecture, where mean time between failures is measured in decades, making application availability of 99.999% possible.

**Automated management and control of services with Kubernetes and OpenStack**

LinuxONE complements Kubernetes for container management in an OpenStack environment by augmenting the DevOps approach through a highly virtualized environment that supports individual virtual machines, clustered nodes, and public, private, or hybrid clouds (multiple clouds).
As shown in Figure 2, each layer of virtualization provides a level of flexibility that developers and testers use to deliver their applications quickly to market. The virtualized environments reduce the amount of physical resources necessary to connect multiple virtual machines, or nodes, and their associated resources.

**Virtualized environments**

Virtualized environments are created using hypervisors at the following levels:

- **Hardware hypervisor**
- **Software hypervisor**

**Hardware hypervisor**

IBM Processor Resource/Systems Manager™ (PR/SM™) is the LinuxONE hardware hypervisor. The physical layer is the hardware such as processor units, memory, and I/O devices. The physical machine can be divided into logical partitions (LPARs). Virtualization at the hardware level allows the systems administrator to maximize resources to improve overall efficiency.

Let us suppose there are four physical processor units on the LinuxONE platform. When defining the LPARs, we might define three LPARs and assign three logical processor units to each LPAR, which is a total of 3*3=9 logical processor units. The logical processor units are “mapped” against physical processor units. Therefore the total number of nine logical processor units is greater than the four physical processor units. However, each operating system will believe it has three processor units available to it.

Memory can be allocated to different LPARs and is managed and controlled to provide isolation for integrity and security purposes as required. I/O devices such as disks and tapes can be shared between LPARs and therefore data can pass from one LPAR to another. Fibre Channel (FC) is the standard protocol for communicating with SAN fabrics and accessing FCP/SCSI devices. Network connectivity can be shared across LPARs and support internal and external industry-standard LAN communications.

**Software hypervisor**

In addition to the virtualization at the hardware level there is an additional level of virtualization. The kernel-based virtual machine (KVM) is a software virtualization technology that enriches the LinuxONE hardware virtualization support. KVM runs in an LPAR and can schedule tasks, dispatch processor units, manage the allocated memory, and interact with I/O devices (storage and network) by way of PR/SM.
KVM creates Linux instances as processes to provide I/O device emulation and device virtualization inside the Linux instance. Table 1 summarizes KVM on LinuxONE key features.

Table 1  KVM on LinuxONE key features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>KVM hypervisor</td>
<td>Supports running multiple Linux instances on a single LPAR</td>
</tr>
<tr>
<td>CPU sharing</td>
<td>Allows for the sharing of CPU resources by Linux instances</td>
</tr>
<tr>
<td>I/O sharing</td>
<td>Enables the sharing of I/O resources among Linux instances</td>
</tr>
<tr>
<td>Memory and CPU over-commitment</td>
<td>Supports the over commitment of CPU, memory, swapping and inactive memory</td>
</tr>
<tr>
<td>Live virtual machine relocation</td>
<td>Enables workload migration with minimal impact</td>
</tr>
<tr>
<td>Dynamic addition and deletion of virtual I/O devices</td>
<td>Reduces downtime to modify I/O device configurations for Linux instances</td>
</tr>
<tr>
<td>Thin-provisioned virtual machines</td>
<td>Allows for copy-on-write virtual disks to save storage</td>
</tr>
<tr>
<td>Hypervisor performance management</td>
<td>Supports policy based, goal orientated management and monitoring of virtual CPU resources</td>
</tr>
<tr>
<td>Installation and configuration tools</td>
<td>Tools available to configure KVM for LinuxONE</td>
</tr>
<tr>
<td>Transactional execution use</td>
<td>Provides improved performance for running multi-threaded applications</td>
</tr>
</tbody>
</table>

Note: PR/SM can be used to allocate memory to LPARs. KVM can then be used to over-commit memory to the virtual machines running in the LPAR in much the same way as a processor unit might be used to maintain integrity and security.

Performance
Priorities can be assigned to LPARs with various weighting factors to achieve the correct balance of resources at the correct time in the correct LPAR. Hypervisors can provide more granular performance control of Linux instances. In addition to the standard processor units, LinuxONE includes dedicated processors for handling I/O, thus enhancing performance by allowing the standard processor units to continue work during I/O operations.

Applications deployed on LinuxONE can be designed to use simultaneous multithreading (SMT) to increase processing efficiency and throughput. Single-instruction, multiple-data (SIMD) encourages further performance enhancements in analytics where information is key to be predictive, real-time, or within a time period that provides the best insight for the application.

Storage and network connectivity enters the LinuxONE platform physically, but can then be securely directed to virtual environments making high use of the virtualization and minimizing physical paths from virtual machine to virtual machine and from LPAR to LPAR.

Figure 3 on page 7 illustrates the LinuxONE storage and network connections. A Hardware Management Console (HMC) is available to configure the platform.
Dynamic Partition Manager

Dynamic Partition Manager (DPM) is a management infrastructure tool available for IBM LinuxONE by way of the HMC. It is intended to simplify virtualization management through a guided management interface to define the LinuxONE hardware and virtual infrastructure, including integrated dynamic I/O management that runs the KVM hypervisor. Typical uses of DPM include:

- Create and provision an environment, including new partitions, assignment of processors and memory, and configuration of I/O adapters
- Manage the environment, including the ability to modify system resources without disrupting workloads
- Monitor the environments to maintain system stability and prioritized resource consumption

Security layers

LinuxONE can be configured to isolate or share data at different levels, such as the application, operating system, and hypervisor level.

Cryptography with CP Assist for Cryptographic Function support and Crypto Express

The option to fully encrypt data is available by using dedicated cryptographic processors for pervasive encryption. These cryptographic processors are additional to the standard processor units that process the applications, thus gaining valuable performance throughput by offloading the encryption tasks onto these specialized cryptographic processors.

LinuxONE offers cryptographic engines that provide high-speed cryptographic operations. The following cryptographic engines can be used for encryption:

Central Processor Assist for Cryptographic Function (CPACF)

A high-performance, low-latency coprocessor that performs symmetric encryption and calculates message digests (hashes) in hardware. The AES, DES/TDES, SHA-1, SHA-2, and SHA-3 algorithms are supported. The
cryptographic function is provided through a set of instructions that are available in hardware on every processor unit.

**Crypto Express**
A tamper-sensing and tamper-responding adapter that provides acceleration for high-performance cryptographic operations. This specialized hardware performs AES, DES/TDES, RSA, Elliptic Curve (ECC), SHA-1, and SHA-2, and other cryptographic operations. It also supports specialized high-level cryptographic APIs and functions. Crypto Express adapters are designed to meet the FIPS 140-2 Level 4 and PCI HSM security requirements for hardware security modules.

**Architectural expansion, compatibility and longevity**
The architecture must allow for changes in both the hardware and software to continue meeting rapidly changing needs. If the hardware and software components reach functional saturation then the architecture itself must expand (not change) to allow the hardware and software to grow and still be compatible with previous iterations and deployments. LinuxONE is founded on a solid and proven architecture to fulfill these requirements.

**What’s next: How IBM can help**
Register with the IBM LinuxONE Community Cloud for access to lots more resources and give it a try! Simply go to: http://www.ibm.com/Linuxone/try

Figure 4 shows to IBM LinuxONE Community Cloud welcome window.

![IBM LinuxONE Community Cloud](image.png)

*Figure 4   IBM LinuxONE Community Cloud*
Resources for more information

For more information about the concepts highlighted in the paper, see the following resources:

- IBM LinuxONE
  http://www.ibm.com/LinuxONE/
- Red Hat
  http://www.redhat.com
- SUSE
  http://www.suse.com
- Ubuntu
  http://www.ubuntu.com
- IBM Cloud Private
  http://www.ibm.com/cloud/private
- Open Container Initiative
  https://www.opencontainers.org/
- Kubernetes concepts
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