SUSE® Linux Enterprise Server for IBM Z and LinuxONE

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What is IBM Z?

IBM Z servers are large-scale computer systems which are mainly used by customers for business-critical installations in organizations which need very high availability and reliability. For such organizations, IBM Z machines normally provide a lower total cost of ownership than other platforms, especially when running a variety of workloads concurrently. IBM Z servers have become well known for server virtualization and workload consolidation through their superior capabilities, which provide the opportunity to minimize IT costs. Linux environments on IBM Z servers build on the outstanding capabilities of z/VM virtualization. They focus on optimal resource utilization, high flexibility, easy and fast provisioning, load-balancing and efficient systems management. The IBM Z hardware technology is designed to run multiple and different workloads in parallel, and provides a balanced system, internal networking, and unmatched levels of availability and security.

What is IBM LinuxONE?

IBM LinuxONE servers are large-scale computer systems that run enterprise Linux and deliver performance, data protection, service continuity and efficiency. LinuxONE is open, with the freedom and agility of open source and standards through enterprise Linux. LinuxONE is fast, with the ability to manage 30 billion RESTful web interactions per day with sub-second response time. LinuxONE is trusted and certified as the most secure, open platform and proven to deliver uninterrupted service. And LinuxONE is affordable, with elastic cloud pricing that is 60% less than public cloud and 32% less than on-premises cloud. The IBM LinuxONE Emperor server is an I/O superhero that scales to support 30 billion RESTful web interactions per day, without fail. It delivers the ultimate flexibility, scalability, performance and security for business-critical Linux applications. With a huge capacity range, you can grow to veritably limitless scale to handle the most demanding workloads. The IBM LinuxONE Rockhopper server delivers unprecedented performance, security and resiliency in an entry-level server. This new Linux platform delivers 40 percent more virtual containers per core than the previous version, and delivers massive, high-performance I/O throughput for the demands of a growing business.

Is SUSE® Linux Enterprise Server for IBM Z and LinuxONE the right hardware platform for me?

SUSE Linux Enterprise Server for IBM Z and LinuxONE running on an IBM mainframe is the ideal choice for customers with existing mainframes that want to add Linux and benefit from the combined advantages, as well as new customers that decide for the first time to buy an IBM Z or LinuxONE machine running Linux. Mainly this combined solution is ideal for customers that:

- Host hundreds of virtual servers that run a mix of workload types and need to consolidate their environment

- Are experiencing or projecting IT growth and want a better way to manage that growth with z/VM
- Struggle to host I/O and data-intensive workloads in virtual servers with acceptable levels of performance, scalability, availability, capacity planning or disaster recovery
- Need high I/O bandwidth and scalability, or rock-solid system security

What is z/VM?

z/VM is the virtualization technology in IBM Z. In other words, it is an operating system hypervisor designed for IBM Z (or any equivalent server designed to the z/Architecture). Using z/VM you can run different operating systems such as z/OS and SUSE Linux Enterprise Server for IBM Z and LinuxONE with different workloads in parallel and in virtual machines on the host mainframe.

In addition, z/VM lets you remap and share existing system resources. This means that you can fine tune your virtual environment (even dynamically) to adapt to existing and changing needs. You can add capacity (in the CPU, I/O and network) on the fly and redirect it if you need it elsewhere.

What is SUSE Linux Enterprise Server for IBM Z and LinuxONE?

SUSE Linux Enterprise Server for IBM Z and LinuxONE is a commercial Linux operating system specifically tailored for the mainframe. This means that various z/VM operating system and IBM Z and LinuxONE hardware features are exploited by SUSE Linux Enterprise Server to ensure that resource sharing, disaster recovery and other capabilities are available for SUSE Linux Enterprise Server for IBM Z and LinuxONE.

SUSE Linux Enterprise Server for IBM Z and LinuxONE lets you consolidate existing distributed workloads and bring new workloads onto IBM Z servers to help minimize costs, reduce downtime, decrease data center complexity and increase business agility.

SUSE Linux Enterprise Server for IBM Z and LinuxONE ensures protection against outsider threats for IBM Z installations with support for IBM Secure Execution and Secure Boot.

I am new to Linux on IBM Z. What is an IFL?

An Integrated Facility for Linux, or IFL for short, is a specialty engine for the IBM mainframe dedicated to running Linux with or without z/VM. IFLs are one of three types of mainframe processors expressly designed to reduce software costs. (The other types are zAAP for Java code and zIIP for DB2.) Microcode restricts IFLs to Linux workloads by omitting some processor instructions not used by the Linux kernel.

In what ways can Linux be run on the mainframe?

On an IFL, Linux can run in standalone mode in a logical partition (LPAR) and under z/VM. Currently, approximately 95% of Linux deployments on IBM Z are run under z/VM.

Visit **www.vm.ibm.com** for more information.

What are the benefits of SUSE Linux Enterprise Server for IBM Z and LinuxONE?

When you combine Linux with IBM's industry-leading virtualization technology—z/VM—running in an IBM Z environment, it delivers the high level of availability and productivity required in today's global, networked environment. Leveraging all of these exceptional IBM Z and LinuxONE capabilities with Linux on z/VM and KVM can improve the total cost of ownership in your IT infrastructure. Together, IBM and SUSE are introducing IT organizations to the compelling business value of hosting virtual servers on IBM Z and LinuxONE with z/VM and Linux. With SUSE Linux Enterprise Server for IBM Z and LinuxONE, you can take advantage of the following benefits:

- Reduced training costs and increased productivity of IT staff
- Reduced software costs by consolidating a large number of virtual machines per IBM Z or LinuxONE core
- Reduced energy costs and power usage
- Reduced facilities costs and floor space with dense server consolidation on IBM Z or LinuxONE

I heard that mainframes, when used for server virtualization and running Linux, may lower total cost of ownership (TCO) considerably. What kind of savings do I get?

You can share per-processor software licenses among multiple Linux virtual servers running on a single mainframe. These processors can either be a standard engine or an IFL engine. An IFL is a specialty processor from IBM that is designed to make it more economical to run Linux workloads on the mainframe. An Oracle license for a standard engine or IFL, for example, is the same price as an Oracle license for a one-processor x86 server.

A mainframe requires only about 20% of the floor space and power use of comparable capacity x86 servers. When IBM releases a new processor technology, it is typically much faster and has more features. IFL owners will not have to pay for the upgraded IFLs in the new machine. This is not common practice among vendors running Linux on x86 servers.

What are the most important advantages, in terms of functionality, that are gained by running SUSE Linux Server on a mainframe?

- Faster server provisioning in the form of virtual servers (minutes or hours versus days and weeks)
- Higher performance communication among Linux virtual servers and other system components such as z/VM and z/OS running on the same IBM Z and LinuxONE hardware
- Inherited disaster recovery
- Higher utilization for mixed workloads
- "Data center in a box"—Multiple complete in-tier applications in one physical footprint

What workloads are best suited for SUSE Linux Enterprise Server for IBM Z and LinuxONE?

A mixture of high I/O transaction-oriented workloads and moderately CPU intensive workloads are best for mainframes; however, Oracle, SAP, IBM middleware, and many other ISVs contribute to the more than 3,150 applications running on Linux on the mainframe. Almost all of IBM's middleware applications run on SUSE Linux Enterprise Server for IBM Z and LinuxONE. In addition, hundreds of open source applications that run on SUSE Linux Enterprise Server for x86 servers, such as Apache, MySQL and Samba, also run on the mainframe.

Does SUSE Linux Enterprise Server for IBM Z and LinuxONE inherit other advantages from the SUSE Linux Enterprise platform?

Besides the specific IBM Z features, SUSE Linux Enterprise Server for IBM Z and LinuxONE also has some unique advantages that come with the SUSE Linux Enterprise platform:

- SUSE Linux Enterprise Server for IBM Z and LinuxONE is part of the SUSE Linux Enterprise common code base. This means the versions, and thereby the source code, of all core packages of the SUSE Linux Enterprise product family are the same—from the desktop to the mainframe. The toolchain, like compilers and libraries (glibc), are the same across the supported hardware architectures. The common code base guarantees product consistency and a persistent look and feel, which lets you leverage the skills of your IT staff. Additionally, it provides for the highest code quality, better supportability and preemptive code maintenance.
- Thanks to the common code base, SUSE provides new innovative core technologies that improve efficiency and help you stay competitive for all architectures, including IBM Z.

Is it true that SUSE Linux Enterprise Server ships with some unique tools?

With every SUSE Linux Enterprise Server for IBM Z and LinuxONE subscription, you get access to unique tools for systems management and increased availability:

- The YaST® installation and configuration framework is unique because it covers a wide range of management tasks and features in an intuitive graphical interface. Developed to provide an extensible and standardized means of systems administration, YaST serves three main purposes: the installation of SUSE Linux Enterprise products on a system, the configuration of the installed system, and the administration of the installed system.
- AutoYaST provides fully customizable, automatic and remote Linux installation for large numbers of systems that share a similar environment and similar—but not necessarily identical—hardware, and which perform similar tasks.
- The downloadable Subscription Management Tool for SUSE Linux Enterprise is integrated with

SUSE Customer Center and provides a repository and registration target that is synchronized with SUSE Customer Center. You can host the most recent version of the tool on IBM Z servers as well. The Subscription Management Tool helps you centrally manage software updates within the firewall on a per-system basis, while maintaining your corporate security policies and regulatory compliance. In addition, it helps you track your entitlements in large deployments. And using the tool, you can avoid redundant bandwidth requirements by downloading all patches at once. It is included with every SUSE Linux Enterprise subscription at no additional cost—while the competition is charging for comparable functionality—and is fully supported.

- Unlike other vendors, SUSE includes the SUSE Linux Enterprise High Availability Extension with every subscription, making high availability affordable. This extension helps you maintain business continuity, protect data integrity and reduce unplanned downtime for your mission-critical workloads. Learn more at **www.suse. com/products/highavailability/**.

What's new with SUSE Linux Enterprise Server for IBM Z and LinuxONE 15 SP2:

SUSE Linux Enterprise Server 15 SP2 has support for all the latest IBM z15 and LinuxONE III Single Frame machines including:

- **High performance and throughput** with support for the latest technology advances in SIMD (Single Instruction, Multiple Data) and SMT (Simultaneous Multithreading) across the full range of IBM Z and LinuxONE systems.

- **Increased security and data protection by supporting** the latest cryptographic acceleration for secure-key operations and new hardware assists for fast data encryption. Incorporating IBM Secure Execution for Linux provides a Trusted Execution Environment that is designed to run large numbers of workloads in full isolation at scale, with enterprise-grade confidentiality and protection of sensitive data from internal and external threats across the hybrid cloud environment. Additionally, Secure Execution extends to containers, enabling protection of sensitive databases and blackchain

services. In this scenario, Kubernetes manages the orchestration of containers, but it has no access to the data inside the Secure Execution environment container.

- **Enhanced virtualization capabilities** to boost resource utilization using KVM and z/VM, giving you the ability to create several virtual machines that run on a single processor and handle multiple workloads. This lets you reduce or eliminate the need to buy more hardware and lets you consolidate physical systems to shrink your data center footprint and simplify maintenance for your IT staff.

- **Advanced RAS capabilities increase reliability and reduce costs,** providing extra dimensions of availability and ensuring the highest levels of security while reducing your planned and unplanned downtime and supporting the legendary RAS characteristics of IBM Z.

- **Improved operational efficiency** with tools you won't find anywhere else and by taking advantage of the networking and communications features for OpenFabrics Enterprise Distribution, shared memory communications and enhanced HiperSockets support. Our systems management tools dramatically reduce tedious, complicated and labor-intensive maintenance.

- **Maximize system uptime and availability for critical systems** with Live Patching for IBM Z and LinuxONE. Improve business continuity and save costs by reducing downtimes, increasing service availability and enhancing security and compliance.

What's new with SUSE Linux Enterprise Server for IBM Z and LinuxONE 15?
SUSE Linux Enterprise Server 15 GA has improved support for IBM z13 and IBM z14 machines. This following new features are supported:

- With z14, the hardware provides an indication of the configuration level of SIE, for example LPAR or KVM. IBM z14 sample configurations help to analyze and optimize KVM performance.
- CPU-MF Hardware Counters are added for IBM z13 and z13s. You can now access counters from the MT-diagnostic counter set that is available with

IBM z13. You can also specify z13 specific counters using their symbolic event names and obtain counter descriptions with the lscpumf utility.

- For IBM z14 machines, access to the host's INVALIDATE PAGE TABLE is provided via the Guest Address-Space-Control Element (ASCE). The KVM host kernel can use the host DAT-enhancement 1 facility to avoid unnecessary purging of guest TLB entries.
- Store Hypervisor Information (STHYI) from LPAR is available in KVM. Non-privileged user-space applications running on KVM can retrieve hypervisor capacity data through the LPAR if not provided by the Linux kernel.
- KVM guests can now use CPU features, including CPACF functions, that were introduced with IBM z14.
- The LLVM compiler supports IBM z14 instructions forimproved performance.
- OpenSSL, ibmca, and libica support IBM z14 instructions for AES-GCM-based encryption of data in flight.
- Support for the True Random Number Generator (TRNG, CPACF MSA7) in IBM z14 machines via CPACF. This improves the availability of random data in the kernel entropy pool.
- libica supports hardware acceleration for the SHA3 algorithm (CPACF MSA6) using CPACF hardware in IBM z14 machines.
- Improved performance on IBM z14 machines through enhanced instruction set support in the toolchain.
- The SIMD instructions for IBM z14 can be used in user space for improved performance of analytic workloads and math libraries.

The following new features are supported in SUSE Linux Enterprise Server 15 GA under KVM:

- Standard network boot setups can be used to deploy KVM guests.
- LOADPARM and BOOTPROG are fully supported. A boot menu selection is available during IPL, for example, to recover from a defective KVM guest operating system.
- Keyless Guests are supported for performance gains through improved memory handling for workloads running on Linux.
- Guarded Storage Facility is supported for improved performance of all Java workloads on KVM virtual servers.
- Store Hypervisor Information (STHYI) from LPAR is available in KVM. Non-privileged user-space

applications running on KVM can retrieve hypervisor capacity data through the LPAR if not provided by the Linux kernel.
- Machine checks caused by failing KVM guests are now targeted at the KVM virtual server instead of the KVM hypervisor, thus making the hypervisor more resilient.
- TLB Purge Enhancements are supported under KVM. This improves performance for KVM guests, in particular when subject to memory pressure.
- Transparent Facility Bit Handling is supported. Hardware functions that do not need a specific configuration in the KVM hypervisor are enabled for KVM guests.
- The IBM Call Home feature is enabled for KVM.

For a complete and detailed list of what's new in version 15, please refer to the Release Notes at **www.suse.com/releasenotes/x86_64/SUSE-SLES/15/**.

What's new with SUSE Linux Enterprise Server for IBM Z and LinuxONE 12 Service Pack 3 (SP3)?
SUSE Linux Enterprise Server for IBM Z and LinuxONE 12 SP3 provides support for some exciting new technology for Linux on IBM Z:

- Optimize workloads on IBM Z with full support for SUSE KVM on Z. Kernel-based Virtual Machine (KVM) is an innovative full virtualization solution for Linux. It consists of a loadable kernel module that provides the core virtualization infrastructure and a processor specific module. Using KVM, you can run multiple virtual machines running unmodified operating system images. Each virtual machine has private virtualized hardware: a network card, disk, graphics adapter, etc. SUSE KVM is included in the base and is now fully supported.
- Increase data security for IBM Z with enhanced cryptographic support for the latest Public Key Cryptography Standards and Crypto hardware acceleration.

What's new with SUSE Linux Enterprise Server for IBM Z and LinuxONE 12 Service Pack 2 (SP2)?
SUSE Linux Enterprise Server for IBM Z and LinuxONE 12 SP 2 provides support for some exciting new technology for Linux on IBM Z.

- Support for the latest technology advances in SIMD (Single Instruction, Multiple Data) and SMT

(Simultaneous Multithreading) across the full range of IBM LinuxONE and IBM Z
- Complete support for the newest virtualization capabilities of IBM KVM and z/VM, and the latest advances in container management
- Networking and communications improvements such as OpenFabrics Enterprise Distribution, shared memory communications, and enhanced HiperSockets support
- Now certified for FIPS 140-2 and supports the latest cryptographic acceleration for secure-key operations and new hardware assists for fast data encryption
- Accessibility to open source packages for IBM Z users through Package Hub which includes validated open source software for IBM LinuxONE and IBM Z

What's new with SUSE Linux Enterprise Server for IBM Z and LinuxONE 12 Service Pack 1 (SP1)?

SUSE Linux Enterprise Server for IBM Z and LinuxONE 12 SP 1 provides support for some exciting new technology for Linux on IBM Z.

- KVM for IBM Z provides open source virtualization for the IBM mainframe. Using the combination of KVM virtualization and IBM Z, you have the performance and flexibility to address the requirements of multiple, differing Linux workloads. To make sure our mutual customers get the best integrated Linux-based virtualization solution for IBM Z, SUSE is closely collaborating with IBM on its KVM for IBM Z technology and provides full support for this technology.
- Containers are a virtual environment within the Linux OS instance. Containers have similar resource isolation and allocation benefits as virtual machines but a different architectural approach allows them to be very portable and flexible. Docker is a specific implementation of a container solution. It is a powerful tool to build, modify, deploy, run, and manage containers. It comes with an extreme focus on efficiency and fast response times. With SUSE Linux Enterprise Server for IBM Z and LinuxONE 12 SP1, we ship the foundation for the support of container engine from open source Docker project on IBM Z.

In addition, we deliver new capabilities and feature enhancements that help you accelerate innovation, increase uptime and improve operational efficiency.

What is the pricing for the SUSE Linux Enterprise Server for IBM Z and LinuxONE?

SUSE Linux Enterprise Server for IBM Z and LinuxONE is priced per-IFL specialty engine or processor. However, SUSE recognizes the challenges customers are facing in enterprise data centers, and the pressure to cut costs. Thus, we offer a special pricing model—the so-called multi-IFL pricing. This pricing model provides volume discounts for subscriptions of SUSE Linux Enterprise Server for IBM Z and LinuxONE to multiple IFLs.

The commercial terms are the same as those for the usual subscription model for SUSE Linux Enterprise Server. With the multi-IFL pricing model, subscriptions are available for 1 IFL, 2 to 5 IFLs, 6 to 11 IFLs, and 12 or more IFLs. All multi-IFL subscriptions for SUSE Linux Enterprise Server for IBM Z and LinuxONE for IBM Z Business or Enterprise server mainframes are available either as Basic, Standard or Priority subscriptions. All multi-IFL subscriptions are available for a 1-year, a 3-year or a 5-year subscription term. For more information about the support options for SUSE Linux Enterprise, visit **www.suse. com/support/programs/subscriptions/**.

Why should I choose SUSE Linux Enterprise Server for IBM Z and LinuxONE over other Linux distributions for mainframes?

SUSE Linux Enterprise Server for IBM Z and LinuxONE is the market-leading Linux operating system for IBM Z, and it incorporates more than 15 years of technology expertise for Linux on the mainframe. In 1999, SUSE started its cooperation with IBM and Marist College to move the available Linux code into an enterprise-ready Linux distribution. Since that time, SUSE has been on the forefront of Linux on IBM Z.

SUSE Linux Enterprise Server for IBM Z and LinuxONE has been available to customers since 2000. Entering this new market, it was the only available enterprise-class Linux—commercially maintained and supported—that delivered the reliability, availability and serviceability (RAS) expected by IBM's main frame customers.

Although other enterprise-like Linux offerings entered the market, SUSE Linux Enterprise Server clearly dominates the Linux mainframe market today. When you consolidate workloads using SUSE Linux Enterprise Server for IBM Z and LinuxONE, you receive all the benefits of mainframe computing and Linux, including high reliability, immense scalability, solid security and the ability to consolidate distributed workloads cost effectively.

What is the relationship between SUSE and IBM in the development of SUSE Linux Enterprise Server for IBM Z and LinuxONE?
SUSE and IBM continue to work very closely together in Germany at the SUSE office in Nuremberg and IBM's Boeblingen development center. SUSE continues to be the first to take advantage of the hardware capabilities of IBM's Z for Linux and is typically first to work with IBM to support new features and to make those advancements available in the mainstream Linux kernel. SUSE and IBM, in conjunction with IBM's mainframe customers, are working together to determine what changes to make to the Linux kernel so you can take full advantage of IBM Z hardware and the z/VM operating system.

How can I purchase SUSE Linux Enterprise Server for IBM Z and LinuxONE?
You can purchase SUSE Linux Enterprise Server for IBM Z and LinuxONE from your IBM sales or business partner representative when you are purchasing a new IBM Z machine, or when you are purchasing new IBM IFLs for your existing mainframe. You can also purchase it directly from SUSE. You can simply call your SUSE sales representative or use the **link below** to request a sales call.

What are some of the features that have been implemented with SUSE Linux Enterprise Server for IBM Z and LinuxONE?
To make sure you get the most out of your environment, and so you benefit from the latest hardware innovation, we decided to do an Architecture Level Set that provides state of the art IBM Z processor hardware exploitation for IBM z196, z114, zBC12, zEC12, z13, z14 and z15—as well as the latest LinuxONE models. For you, this means a much faster Linux system with an enhanced compiler and toolchain that help boost your application performance.

In addition, SUSE Linux Enterprise Server for IBM Z and LinuxONE includes many features to improve operational efficiency, increase uptime, and accelerate innovation. Some of these features are:

- **Security:** Support for the latest IBM Z hardware based PKCS #11 cryptographic cards. PKCS #11 is part of the Public-Key Cryptography Standards, and is widely used for access smart cards and in hardware security models. This functionality is required for financial institutions and other organizations that need to ensure encrypted, authenticated and secured transactions. To easily set-up this crypto hardware stack on IBM Z, you can also select a new install pattern in YaST during installation.
- **RAS (reliability, availability, serviceability):** PCHID mapping helps you to determine the physical channel-ID (PCHID) associated with a channel path identifier (CHPID) and results in faster problem resolution. With the kernel support for concurrent Flash MCL (microcode level) updates to Flash storage media during operation, you can apply upgrades without impacting I/O operations to the flash storage media. Disk mirroring with real-time enhancement for IBM Z provides better service availability. With the function Dump to zfcp/SCSI Partition, the SCSI dump tool writes dumps directly to a SCSI partition, without using a file system.
- **Increased operational efficiency and performance:** Improved performance of dasdfmt enhances the speed of the DASD formatting process. This lowers administration time and efforts, and supports growth with the option to use larger future DASDs. Support of transparent large pages provides performance improvements for applications that access large amounts of anonymous memory. The feature multiple netiucv paths for communication between z/VM guests lets you establish multiple netiucv connections between the same two z/VM guests, which results in better scalability for z/VM Linux data exchange and improved performance. The Optimized Compression Library zlib improves performance and lowers processor resource consumption for applications using this library. Support for zPXE Boot provides a similar function to the PXE boot on x86 and x86-64 for easier automated installation.

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