# IBM Emperor II offers a secure, scalable data foundation

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## At a glance

The IBM(R) Emperor II extends IBM LinuxONE™ high-end data-serving leadership with:

- Unmatched performance and vertical scale

  The Emperor II delivers the performance and scale needed to address today's business demands, with 20% more cores, 2.2 times more memory, and 25% more FCP I/O throughput as compared to the inaugural IBM Emperor. It provides a platform that can manage your data as a real-time single source of truth, and one that can respond to business needs with uninterrupted growth and speed while providing a richer user experience. The Emperor II offers:

- Industry-leading Java™ performance, up to 50% faster than on x86 alternatives
- Vertical scale to 170 cores with the equivalent capacity to consolidate hundreds of x86 data-serving cores
- Simplification to make the most of your Linux™ skill base and improve time to value
- Single Instruction, Multiple Data (SIMD) enhancements to accelerate analytic workloads and decimal computations critical to financial applications
- Pause-less garbage collection to enable vertical scaling of Java workloads while maintaining predictable response times

- Efficient and powerful security

  With Emperor II you can protect your valued data, whether in flight or at rest, with low overhead, without changing your applications and with minimal impact to service level agreements (SLAs). It features:

  - Encryption for your data at rest, with no changes to your applications, and with better performance than x86 alternatives
  - Protected key CPACF support where encryption keys are cryptographically protected to help secure your encryption key on disk and in memory, mitigating risk of compromise
  - Industry-leading secure Java performance delivering TLS transactions 2 to 3 times faster than on typical x86 alternatives
  - Protection of data in flight over the network with full end-to-end network security
  - IBM's intention to expand the use of its industry-exclusive IBM Secure Service Container framework to enable the development of container-based applications with industry-leading orchestration enabling users to seamlessly integrate their LinuxONE with their enterprise-wide DevOps container strategy

- Foundational capabilities for data serving and next-generation apps

  With Emperor II you have the flexibility to modernize your data and transactional systems and take advantage of the ever-growing open source movement. You can:

- Add performance, scale, and security without trade-offs to new DB2(R) and open source database as a service (DBaaS) deployments
- Develop new Blockchain applications based on the proven IBM Blockchain Platform
- Consolidate databases for software license and operational savings
- Support data-in-memory applications and new workloads using 32 TB of memory
- Take advantage of very fast I/O capable of over 190K 8K read IOPs per FCP link or 380 8K read IOPs per FCP card

## Overview

**The new IBM Emperor II is a highly engineered system designed to thoroughly protect data, the new business currency, with speed and agility at scale.**

The world is in the middle of a transformation which is having a profound effect on us as individuals, on how businesses are run, and on how business is transacted. In this ever-more-digital world, the new currency is data and the insights that data can provide. It is a world that requires ultimate trust in the data that businesses collect, create, and store.

As a natural evolution of the digital transformation, the complexity of the data value chain has also expanded. The expectations of consumers, suppliers, and business partners have grown. They demand security, transparency, and greater value in every interaction and transaction as this new currency is exchanged. Securing data from both internal and external threats is of utmost importance, yet only a portion of data is adequately protected today. Failure to secure such data has both financial and reputational consequences.

Digital experiences are no longer hosted entirely on premises through data centers but are delivered in combination with hybrid clouds. This is by design as businesses must be open and connected to drive innovation at speed. They must accelerate development and delivery of secure, scalable services to address new opportunities and challenges before a competitor steals the advantage.

**IBM Emperor II is designed to provide highly securable data for businesses looking to thrive in a data-centric economy.**

## Key prerequisites

Refer to the Hardware requirements and Software requirements sections of this announcement.

## Planned availability date

- September 13, 2017
  - Features and functions for the IBM Emperor II
  - IBM Emperor II Models LM1, LM2, LM3, LM4, and LM5
  - Field installed features and conversions on IBM Emperor II that are delivered solely through a modification to the machine's Licensed Internal Code (LIC)

- TKE 9.0 LIC (#0879) on Emperor II, Emperor, and Rockhopper
- HMC (#0082) on Emperor II, Emperor, and Rockhopper
- HMC Rack Mount (#0083) on Emperor II, Emperor, and Rockhopper
- TKE Rack Mount w/4768 (#0085) on Emperor II, Emperor, and Rockhopper
- TKE w/4768 (#0086) on Emperor II, Emperor, and Rockhopper

- December 15, 2017
  - z/VM(R) guest exploitation support for the Instruction Execution Protection Facility
  - z/VM guest exploitation support for pause-less garbage collection
  - z/VM support for encrypted paging

- December 31, 2017
  - MES features for IBM Emperor II Models LM1, LM2, LM3, LM4, and LM5
  - MES upgrades for IBM Emperor II LMX models to IBM z14 M0X models
  - IBM HMC Mobile for Z and LinuxONE

Availability of programs with an encryption algorithm in France is subject to French government approval.

## Description

IBM LinuxONE ® is an all-Linux enterprise platform for open innovation that combines the best of Linux and open technology with the best of enterprise computing in ONE platform. It delivers a single system built on one of the industry's fastest commercially available server processors and is built to be the backbone of the interconnected data-driven era, setting new standards in transaction volume, speed, and trust.

The newest member of the IBM LinuxONE family, the IBM Emperor II (Emperor II), is designed to provide a secure, scalable data foundation. IBM Emperor II provides a scalable, highly available infrastructure that delivers differentiated value to enable business growth, reduce cost, and protect existing investments.

Today's announcement continues IBM's Linux enterprise server leadership with IBM Emperor II, offering:

- More total system capacity as compared to the original LinuxONE Emperor for exceptional scale in a single footprint.
- Faster uniprocessor performance as compared to the original LinuxONE Emperor.
- 170 cores to configure (versus 141 on the original LinuxONE Emperor).
- Up to 32 terabytes (TB) of available Redundant Array of Independent Memory (RAIM) real memory per server to help improve transaction response times, lower CPU costs, simplify capacity planning, enlarge in-memory buffer pools, and ease deploying memory-intensive workloads.
- 2x more on-chip cache per core, compared to the original LinuxONE Emperor, to minimize memory waits while maximizing the throughput of concurrent workloads -- perfectly optimized for data serving.
- A design for pervasive encryption allowing you to encrypt many new data sets transparently, which can help you to provide an envelope of protection around data placed on IBM LinuxONE Emperor™ II. This includes cryptographic performance improvements with the Crypto Express6S (#0893) and the Emperor II processor-based cryptography with the CP Assist for Cryptographic Functions that helps enable the protection of data in flight or at rest.
- Hardware accelerated encryption on every core with the Central Processor Assist for Cryptographic Function (CPACF) feature which is designed to provide faster encryption and decryption than previous servers.
- Economies of scale with next-generation multithreading (SMT) for Linux workloads, new support for the I/O System Assist Processor (SAP), 2x AES performance over the original LinuxONE Emperor, a True Random Number Generator, SHA3 support, and RSA/ECC acceleration.
- New instructions in Single Instruction, Multiple Data (SIMD) which are designed to give a performance boost for traditional workloads using COBOL and new applications like analytics.
- FICON® Express16S+ (#0427, 0428) which is designed with a boost in I/O rates and a reduction in single stream latency to help absorb large application and transaction spikes driven by large unpredictable analytic and mobile workloads.
- Improved compression ratio (using Huffman coding) and order-preserving compression for the on-chip compression coprocessor which results in fewer CPU cycles to enable further compression of data, improving memory, transfer, and disk efficiency.
- 10 GbE RoCE Express2 (#0412) with 4x more virtual functions per adapter and a performance improvement.
- IBM Hardware Management Console (HMC) 2.14 with simplification updates to improve workspace and manage system time. New security features include Multifactor Authentication and a new HMC Mobile application for monitor and recover action controls.
- IBM Secure Service Container which can be used to create isolated partitions helping to protect data and applications automatically – helping to keep them safe from insider threats as well as external cybercriminals.
- IBM Dynamic Partition Manager enhancements which provide a simplified, consumable, enhanced IBM LinuxONE experience, reducing the barriers of adoption for new and existing Linux, KVM for IBM Z Systems, and z/VM clients.
- Trusted Key Entry (TKE) 9.0 License Internal Code (LIC).
- Improved Java performance through support for reducing program pauses during Java garbage collection.
- Nonraised floor option, offering flexible possibilities for the data center.
- Optional water cooling, providing the ability to cool systems with user-chilled water.
- Optional high-voltage dc power, which can help IBM LinuxONE clients save on their power bills.
- Optional top exit power and I/O cabling designed to provide increased flexibility.
- New ASHRAE class A3 for robustness, data center flexibility, and energy savings.

- Upgradability within the IBM LinuxONE Emperor II family, and into the z14 family.

***The performance advantage***

IBM Emperor II is available with up to 170 configurable cores using one of the world's fastest commercial processors running at 5.2 GHz, for impressive performance and massive scaling. It can support up to 8,000 virtual Linux servers on a single footprint.

***Next-generation availability***

The IBM Emperor II processor builds upon the Reliability, Availability and Serviceability (RAS) of the original LinuxONE Emperor, with the following RAS improvements:

- IBM Emperor II Level 3 cache enhancements using powerful symbol ECC that now spreads cache data over multiple physical cache arrays. This enables the detection and correction of multibit errors, making the Level 3 cache more resilient and fault tolerant.
- Preemptive DRAM marking added to main memory to isolate and recover failures more quickly.
- Improved small array error handling in the processor cores.
- Additional error thresholding to the processor core to isolate "sick but not dead" failure scenarios.
- An increase in the number of "Resource Groups" (from 2 to 4) to help reduce the impact of firmware updates and failures.

***Common Criteria Evaluation Assurance Level 5+ (EAL 5+) certification***

The IBM Emperor II is designed for Common Criteria Evaluation Assurance Level 5+ (EAL5+) certification for security of logical partitions. This means that the IBM Emperor II is designed to prevent an application running on one operating system image on one LPAR from accessing application data running on a different operating system image on another LPAR on the server.

***Common Cryptographic Architecture (CCA) enhancements***

***PCI PTS HSM compliance***

The Crypto Express6S coprocessor with CCA 6.0 is designed to comply with the Payment Card Industry (PCI) PIN Transaction Security (PTS) Hardware Security Module (HSM) Standard. PCI security standards are developed by the Payment Card Industry Security Standards Council to help ensure security in the payment card industry with guidance and direction to HSM vendors to help meet the security needs of the financial payments industry.

The requirements in PCI PTS HSM standards are intended to enhance security for operations that process sensitive data with requirements in key management, HSM API functions, device physical security, controls during manufacturing and delivery, device administration, and a number of other areas.

The Crypto Express6S manufacturing and delivery processes are enhanced with Emperor II to comply with PCI PTS HSM and, with CCA 6.0, introduce several new capabilities both for PCI PTS HSM compliance mode and for general use:

1. A **new derived key hierarchy** so that PCI PTS HSM compliance-tagged key tokens may be used alongside existing keys and services in a nondisruptive fashion -- with existing master keys.
2. **Nondisruptive transition to PCI PTS HSM mode:** Using TKE 9.0, a domain of the Crypto Express6S coprocessor with CCA 6.0 may be placed in PCI PTS HSM compliant mode with no disruption to other domains or to normal or legacy services using the domain that is moved to PCI PTS HSM compliant mode.
3. **Secure Audit Log** hosted from the Crypto Express6S coprocessor with CCA 6.0. Required by the PCI PTS HSM standard, this audit log covers all administrative

actions and is managed by TKE 9.0. The new audit log is nondisruptive to normal application processing for domains where it is active.

4. **Secure public key infrastructure:** The Crypto Express6S coprocessor with CCA 6.0 adds native X.509 certificate support including PKCS #10 certificate request generation through a new PKI hosted from the coprocessor. Trust chain certificates are managed via TKE 9.0.
5. **Migration planning assistance** through active application reporting. The Crypto Express6S coprocessor with CCA 6.0 can report in real time what operations and keys will need attention if they are planned for use with PCI PTS HSM compliant-tagged keys. Report details and activity depend on host access library/operating system configuration.
6. **CPACF exportable AES cipher key** support added for AES cipher keys created using new options in CCA 6.0.

***Trusted Key Entry (TKE) 9.0 Licensed Internal Code (LIC)***

The following functions are planned to be supported in the TKE 9.0 level of LIC:

- **Crypto Express6S Coprocessor support:** TKE 9.0 is required for managing Crypto Express6S cryptographic coprocessors and manages them through the same Crypto Module notebook functions as previous generations of Cryptographic modules.
- **Key material copy to alternate zone:** TKE 9.0 allows you to copy key material from smart cards in one TKE zone to smart cards in another zone. You might have old 1024 bit strength TKE zones, and may wish to move or copy the key material in those zones into a new, stronger TKE zone. To use this new feature you create new TKE and/or EP11 smart cards on your TKE 9.0 system. You enroll the new TKE and/or EP11 smart cards in an alternate zone. This allows you to copy smart card content from a smart card enrolled in the alternate zone.
- **Save TKE data directory structure with files to USB:** TKE data can be saved to, or restored from, removable media in the same directory structure they were found on the TKE.
- **Create key parts without opening a host:** The TKE application now has the ability for administrators to create key parts without opening a host. This allows the key administrator to create key parts while being offline or before any hosts are defined. This feature can be found in the TKE application under the **Utilities > Create CCA key parts** pull-down menu.
- **New TKE Audit Log application:** There is a new **TKE Audit Log** application available for the Privileged Mode Access ID of AUDITOR. This application provides a new, easy-to-use interface to view the TKE workstation security audit records from the TKE workstation.
- **Heartbeat audit record:** TKE workstations cut an audit record when the TKE boots or when no audit events have occurred during a client-configured duration of time. The record shows the serial number of the TKE local crypto adapter and indicates if the local crypto adapter has been changed since the last check.
- **Performance improvements for domain groups:** With CCA 5.3 and later firmware levels, and TKE 9.0, performance may be improved for operations performed with large domain groups. For example, consider a domain group of 85 domains and a Clear New Master Key Register operation is performed from the TKE. The number of TKE commands issued to the Crypto Express(R) coprocessor from the TKE will be reduced from 85 to 1, thereby reducing the time to complete the operation.
- **Master key part entry on EP11:** Known master key parts can now be entered and saved on smart cards for coprocessors configured in EP11 mode using TKE 9.0. This enables key custodians to manage EP11 master key parts in a fashion that is consistent with coprocessors configured in CCA mode.
- **Smart card readers:** With TKE 9.0, if you have HID/OMNIKEY smart card readers you may continue to use them. See the *TKE User's Guide* for more detailed smart card reader information.
- **New certificate manager for domains:** Every domain will now have the ability to manage a set of parent X.509 certificates for validating operating X.509 certificates used by applications running in the domain. The Crypto Express6S

with CCA 6.0 is designed to meet the PCI-HSM PIN Transaction Security v3.0, 2016 standard.

The following features are related to support for the Crypto Express6S with CCA 6.0.

- **Domain mode management:** With CCA 6.0, individual domains are in one of the following modes:
  - Normal mode
  - Imprint mode
  - Compliant mode

  Imprint and compliant modes were added to help customers migrate to a PCI-HSM compliant mode and meet PCI-HSM PIN Transaction Security v3.0, 2016 requirements. TKE is required to manage Host Crypto Module domains in imprint and compliant mode.

- **Set clock:** With TKE 9.0, you now have the ability to set the host crypto module's clock. The clock must be set before a domain can be placed in imprint mode.
- **Domain-specific Host Crypto Module Audit Log management:** Domains in imprint mode or compliant mode on a Crypto Express6S maintain a domain-specific module audit log. The TKE provides a feature for downloading the audit records so they can be viewed.
- **Domain-specific roles and authorities:** Domains in imprint mode or compliant mode on a Crypto Express6S must be managed using domain-specific roles and authorities. The TKE provides new management features for the domain-specific roles and authorities. The roles are subject to forced dual control policies which prevent roles from being able to both issue and cosign a command. Refer to the *TKE User's Guide* for detailed information on how to manage imprint and compliant mode domains.
- **Setup PCI Environment Wizard:** To help simplify the management of a PCI compliant domain, the TKE now provides a setup wizard that will create a minimum set of required dual control roles and authorities needed to manage a PCI compliant domain. Refer to the *TKE User's Guide* for detailed information on how to manage imprint and compliant mode domains.

***FICON Express16S*** +

With the introduction of **FICON Express16S+ on the IBM Emperor II,** you now have additional growth opportunities for your storage area network (SAN).

FICON Express16S+ supports a link data rate of 16 gigabits per second (Gbps) and autonegotiation to 4 or 8 Gbps for synergy with existing switches, directors, and storage devices. With support for native FICON, High Performance FICON for z Systems™ (zHPF), and Fibre Channel Protocol (FCP), the Emperor II server enables you to position your SAN for even higher performance -- helping you to prepare for an end-to-end 16 Gbps infrastructure to meet the lower latency and increased bandwidth demands of your applications.

The new FICON Express16S+ adapter will work with your existing fiber optic cabling environment, both single-mode and multimode optical cables. The FICON Express16S+ feature running at end-to-end 16 Gbps link speeds will provide reduced latency for large read/write operations and increased bandwidth compared to the FICON Express8S feature.

**Increased throughput for the FCP protocol:** A FICON Express16S+ feature, when defined as CHPID type FCP, conforms to the Fibre Channel Protocol (FCP) standard to support attachment of SCSI devices, to complement the classical storage attachment supported by FICON and zHPF channels. In laboratory measurements, using FICON Express16S+ in an IBM Emperor II with the FCP protocol for small data transfer I/O operations, FICON Express16S+ operating at 16 Gbps achieved a maximum of 380,000 IOs/sec, compared to the maximum of 110,000 IOs/sec achieved with FICON Express16S operating at 16 Gbps. In laboratory measurements, using FICON Express16S+ in an IBM Emperor II with the

FCP protocol and FICON Express16S+ operating at 16 Gbps, FICON Express16S+ achieved a maximum throughput of 3200 MB/sec (reads + writes). This represents approximately a 25% increase in throughput. The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed.

On IBM Emperor II the FCP protocol is supported by z/VM, KVM for IBM Z Systems, and Linux on z Systems. Refer to the Software requirements section.

**Increased throughput for the zHPF protocol:** In laboratory measurements using FICON Express16S+ in an IBM Emperor II with the zHPF protocol and small data transfer I/O operations, FICON Express16S+ operating at 16 Gbps achieved a maximum of 300,000 IOs/sec. In laboratory measurements, using FICON Express16S+ in an IBM Emperor II with the zHPF protocol and a mix of large sequential read and write data transfer I/O operations, FICON Express16S+ operating at 16 Gbps achieved a maximum throughput of 3200 MB/sec (reads + writes) compared to a maximum of 2560 MB/sec (reads + writes) achieved with FICON Express16S operating at 16 Gbps. The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed.

**Cleaning discipline for FICON Express16S+ fiber optic cabling:** With the introduction of 16 Gbps link data rates, it is even more critical to ensure your fiber optic cabling infrastructure performs as expected. Proper fiber optic cleaning and maintenance is required to help ensure that the "data gets through." With 16 Gbps link data rates over multimode fiber optic cabling, link loss budgets and distances are reduced. Single-mode fiber optic cabling is more "reflection sensitive." With high link data rates and single-mode fiber optic cabling there is also less margin for error. The cabling is no longer scratch-tolerant and contaminants such as dust and oil can present a problem. To keep the data flowing, proper handling of fiber trunks and jumper cables is critical as well as thorough cleaning of fiber optic connectors. Work with your data center personnel or IBM personnel to ensure you have fiber optic cleaning procedures in place.

**Channel subsystem (CSS) scalability:** The Emperor II server, like the original LinuxONE Emperor server, has support for six logical channel subsystems (LCSSs) which are required to support the 85 LPARs for Emperor II, and four subchannel sets.

***OSA-Express6S - an Ethernet technology refresh***

A new generation of Ethernet features is being introduced for use in the PCIe I/O drawer and continues to be supported by the 16 GBps PCIe Gen3 host bus. This is an introduction of the full family of features -- 1000BASE-T Ethernet for copper environments, in addition to 10 Gigabit Ethernet (10 GbE) and Gigabit Ethernet (GbE) for single-mode and multimode fiber optic environments. The performance characteristics are comparable to the OSA-Express5S features. They also retain the same form factor and port granularity -- two ports per feature for the 1000BASE-T Ethernet and Gigabit Ethernet features, and one port per feature for the 10 Gigabit Ethernet features.

The OSA-Express6S family of features (#0422, #0423, #0424, #0425, #0426) is exclusive to the z14 and IBM Emperor II. On IBM Emperor II they are supported by z/VM, Linux on z Systems, and KVM for IBM Z Systems hypervisor. Refer to the Software requirements section.

***Dynamic Partition Manager (DPM)***

Dynamic Partition Manager (DPM) provides simplified hardware and virtual infrastructure management, including partition lifecycle and integrated dynamic I/O management for Linux running in an LPAR, under KVM for IBM Z Systems, and under z/VM V6.4. z/VM Single System Image (SSI) clusters are not currently supported within the existing DPM environment.

Using DPM, an environment can be created, provisioned, and modified without disrupting running workloads, and monitored for troubleshooting. Currently, DPM supports FCP storage. Enhancements to DPM simplify the installation of the Linux operating system, and support additional hardware adapters. These enhancements include:

- Support for autoconfiguration of devices to simplify Linux operating system installation, where Linux distribution installers exploit function
- Secure FTP through HMC for booting and installing an operating system via FTP
- Support for OSA-Express 6S, FICON Express 16S+, Crypto Express6S, and RoCE Express2 adapters

A CPC can be configured in either the Dynamic Partition Manager mode or PR/SM™ mode. The mode is enabled prior to the CPC power-on reset (POR).

Dynamic Partition Manager mode requires two OSA-Express6S 1000BASE-T Ethernet features (#0426) for primary and backup connectivity, along with associated cabling (HW for DPM, #0016).

***The IBM Secure Service Container***

The IBM Secure Service Container is a framework for securely deploying software appliances on IBM LinuxONE. Following are the offerings that exploit the Secure Service Container on LinuxONE:

- IBM Blockchain Platform
- IBM Operations Analytics for z Systems- zAware

The Secure Service Container consists of both a firmware framework and a software framework.

The following is an enhancement to the IBM Emperor II IBM Secure Service Container firmware framework:

- Simplification - Dynamic Partition Manager support for dynamic resource management and creation of Secure Service Container LPARs without needing to re-IML.

The following are enhancements that have recently been made to the IBM Secure Service Container software framework:

- Security
  - Help enable secure boot of appliance via system unique key smart card access such that the Secure Service Container or system administrator cannot utilize privileged credentials to see or access the key.
  - Runtime and tamper protection via BTRFS Filesystems for root and data volumes.
- Appliance management
  - Support the addition of FCP (and ECKD™) storage to different disk pools via the appliance UI.
  - Support network configurations managed by IPv4, IPv6, and VLAN configurations from the appliance UI.
  - Enable appliance updates including import from a prior, saved and exported configuration -- avoid losing configuration data (going back to a "Factory Install"-like state); particularly useful for Blockchain, which typically utilizes many concurrently running instances.
  - Support different users and groups via Local LDAP server and UI management.
  - Support starting appliance installer from a running appliance without having to interface with the HMC.
- Usability

– Avoid appliance spoofs by ensuring that a trusted and uniquely signed instance of an appliance is booted only in one LPAR, not multiple LPARs.

***z/Architecture(R) mode:*** As announced on January 14, 2015 with Hardware Announcement ZG15-0001, dated January 14, 2015, beginning with IBM z14, all IBM Z and IBM LinuxONE systems will only support operating systems running in z/Architecture mode. This applies to operating systems running native on PR/SM as well as operating systems running as second-level guests. IBM operating systems that run in ESA/390 mode are either no longer in service or only currently available with extended service contracts, and they are not usable on systems beginning with IBM z14. However, IBM z14 and IBM LinuxONE do provide ESA/390-compatibility mode, an environment supporting a subset of DAT-off ESA/390 applications in a hybrid architectural mode.

All 24-bit and 31-bit problem state application programs originally written to run on the ESA/390 architecture will be unaffected by this change.

***z/VM support for the IBM Emperor II***

With the available PTF for APAR VM65942, z/VM V6.3 and V6.4 provide support that will enable guests to exploit function supported by z/VM on IBM Emperor II, which includes:

- ***z/Architecture support:*** The z/VM Stand-Alone Program Loader (SAPL) utility, DASD Dump Restore (DDR), and the Stand-Alone Dump utility have been enhanced to run entirely in z/Architecture mode. z/Architecture support for these utilities is in the base of z/VM V6.4 and provided for z/VM V6.3 with the available PTF for APAR VM65856. z/Architecture support for the Stand-Alone Dump utility is in the base of z/VM V6.4 and provided for z/VM V6.3 with the available PTFs for APARs VM65921 and VM65922.
- ***New hardware facilities:*** z/VM will enable guest use of new instructions and capabilities available on IBM Emperor II.
- ***ESA/390-compatibility mode for guests:*** IBM Emperor II does not support the full ESA/390 architectural mode. However, IBM Emperor II does provide ESA/390-compatibility mode, an environment supporting a subset of DAT-off ESA/390 applications in a hybrid architectural mode. z/VM will provide the support necessary for DAT-off guests to run in this new compatibility mode, which allows guests such as CMS, GCS, and those that start in ESA/390 mode briefly before switching to z/Architecture mode to continue to run on IBM Emperor II.

  The available PTF for APAR VM65976 provides infrastructure support for ESA/390 compatibility mode within z/VM V6.2, V6.3, and V6.4, and must be installed on all members of an SSI cluster before any z/VM V6.3 or V6.4 member of the cluster is run on an IBM Emperor II server.
- ***Support for Crypto Express6S:*** z/VM support for the new Crypto Express6S (CEX6S) adapter is included for both shared and dedicated guest use. As with the prior crypto adapter support, the CEX6S adapter can be configured as an accelerator or as an IBM Common Cryptographic Architecture (CCA) coprocessor for shared or dedicated use by z/Architecture guests. When the CEX6S adapter is configured as an IBM Enterprise Public-Key Cryptography Standards (PKCS) #11 (EP11) coprocessor, the domains on the adapter can be dedicated to z/Architecture guests, but not shared. With Crypto Express6S support and support for the new and enhanced CPACF functions, z/VM V6.3 and V6.4 provide the prerequisite IBM Emperor II encryption support to enable exploitation by guests in support of pervasive encryption of data in flight and at rest.
- ***Crypto Clear Key ECC operations:*** Clear Key Elliptic Curve Cryptographic (ECC) operations are supported for guests enrolled in the z/VM-managed shared-crypto queue (APVIRT). The shared-crypto queue must be configured with CCA coprocessor domains in order for the function to be virtualized for guest use.
- ***Dynamic I/O support:*** Dynamic I/O support is provided for managing the configuration of OSA-Express6S OSD CHPIDs, FICON Express16S+ FC and

FCP CHPIDs, and RoCE Express2 functions. z/VM supports the defininition and dynamic activation of I/O configurations for Emperor II using HCD.

- ***RoCE Express2 support:*** Guest exploitation support for RoCE Express2 allows the adapters to be brought online and attached to supporting guests for exploitation.
- ***Improved memory management support:*** The IBM Emperor II processor design allows greater concurrency in address translation. This improvement may increase z/VM workloads' performance compared to the original Emperor, particularly when z/VM is configured to exploit multithreading.

***Installing z/VM on the IBM Emperor II***

z/VM V6.4 can be installed directly on an Emperor II server with an image obtained from IBM after August 25, 2017. The PTF for APAR VM65942 must be applied immediately after installing z/VM V6.4.

Current LinuxONE or IBM Z clients using z/VM V6.3, who are interested in running z/VM V6.3 on Emperor II, should first consider moving to z/VM V6.4. If moving to z/VM V6.4 is not a viable option, z/VM V6.3 must be installed on a prior IBM Z server and the PTFs for APARs VM65942, VM65921, and VM65922 must be applied prior to moving the image to Emperor II. After applying all required service and before IPLing z/VM V6.3 on an Emperor II server, an updated SAPL must be installed by using the updated SALIPL MODULE provided by the PTF for APAR VM65856. Otherwise, z/VM V6.3 will not successfully IPL on an Emperor II server. In addition, after applying the PTFs for APARs VM65921 and VM65922, the stand-alone dump program must be re-installed using the updated SDINST utility.

**Guest exploitation support for the Instruction Execution Protection Facility:**

With the PTF for APAR VM65986, planned to be available December 15, 2017, z/VM V6.4 will provide support for guest exploitation of the IBM Emperor II Instruction Execution Protection Facility. This facility provides functionality to help improve the security of programs running on IBM LinuxONE by allowing virtual memory elements to be identified as containing only data. If an attempt is made to fetch an instruction from an address in such an element or if an address in such an element is the target of an execute-type instruction, a Protection Exception will occur.

**Guest exploitation support for pause-less garbage collection:**

With the PTF for APAR VM65987, planned to be available December 15, 2017, z/VM V6.4 will provide support for guest exploitation of the Emperor II Guarded Storage Facility. This facility is designed to improve the performance of garbage-collection processing by various languages, in particular Java.

**Encrypted paging support:**

With the PTF for APAR VM65993, planned to be available December 15, 2017, z/VM V6.4 will provide support for encrypted paging, in support of the Emperor II pervasive encryption philosophy of encrypting data in flight and at rest. Ciphering will occur as data moves between active memory and a paging volume owned by z/VM. Included in the support is the ability to dynamically control whether a running z/VM system is encrypting this data.

**Processor scalability efficiency improvements:**

With the PTF for APAR VM65988, the z/VM hypervisor will be enhanced to manage its spinlocks more efficiently and thereby reduce system overhead. This enhancement will contribute to improved performance and throughput, and thereby help to improve overall system capacity by allowing additional work to be performed. While most workload configurations will benefit to some extent, the improvements are greatest for workloads using large numbers of logical CPUs. The shared-exclusive spinlock manager was replaced with a more cache-efficient design providing greater scalability for the Scheduler Lock (SRMSLOCK). SRMSLOCK reporting in Monitor D0R23 MRSYTLCK was corrected to include time spinning in HCPDSP's internal spin loop that was previously unreported. The support is available

on all hardware supported by z/VM V6.4, including the LinuxONE Emperor II and IBM z14. However, the design for some spinlocks takes advantage of efficiencies unique to the LinuxONE Emperor II and z14.

**Sub-capacity pricing terms for z/VM and select z/VM-based programs:**

Sub-capacity pricing for the z/VM V6 operating environment is available to clients running z/VM Version 6 Release 3 or higher. Software pricing at less than full machine capacity can provide more flexibility and improved cost of computing as a client manages the volatility and growth of new workloads. For more information about Sub-capacity pricing terms for z/VM and z/VM-based programs, see Software Announcement ZP17-0346, dated July 17, 2017.

**z/VM continuous delivery philosophy:**

IBM has adopted a new practice for z/VM, known as the continuous delivery (CD) support model, for delivering new function via PTFs to help enterprises receive function more quickly. IBM will deliver new function via PTFs, while continuing to recognize that base stability is a critical attribute. Clients will continue to receive the same world-class support and assistance from IBM to which they are accustomed as part of the standard Software Subscription and Support (S&S) offering. The z/VM service page provides details on new z/VM functions that have been or will be provided using this continuous delivery model and allows subscribing in order to be alerted when new functions have been made available.

**Additional z/VM V6.4 enhancements during 2017**

The following enhancements for z/VM V6.4 are planned during 2017:

- ***Concurrent I/O support for the IBM XIV® Storage System:*** With the available PTF for APAR VM65929, the z/VM SCSI container enables multiple I/O requests to be issued concurrently to EDEVICEs backed by IBM XIV Storage System hardware, which may improve performance. This support particularly benefits EDEVICE paging I/O or volumes containing multiple minidisks.
- ***Distributed IUCV enhancements:*** With the available PTF for APAR VM65872, the rules for Distributed IUCV CONNECT in a single system image (SSI) environment are revised. This support allows IUCV CONNECT to work in cases that were originally restricted, primarily because they involved a Multiconfiguration Virtual Machine (IDENTITY) user.

  This support also makes it easier for an administrator to change the Distributed IUCV policy for an SSI cluster. Previously, the Distributed IUCV policy within an active SSI cluster could be changed only by shutting down all members at the same time. As this new support is applied to each system, it will be possible for that member to join the cluster regardless of its Distributed IUCV configuration.

- ***NICDEF security control enhancements:*** With the available PTFs for APARs VM65925, VM65926, and VM65931, the NICDEF directory statement is enhanced to provide a set of new operands referred to as Directory Network Authorization (DNA). With DNA, a system administrator can configure and consolidate a virtual NIC device and its network properties in a centralized location --z/VM's User Directory. Operational differences between PORTBASED and USERBASED VSwitches have been eliminated with this support. A system administrator has the option to manage a VSwitch by user, by port number, or using a combination of the two methods. While the management of USERBASED and PORTBASED VSwitches is simplified, Live Guest Relocation of a guest connected to a VSwitch still requires the destination system to have a VSwitch with a PORTBASED or USERBASED designation matching that of the source system.
- ***RACF® security policy enhancements:*** With the available PTFs for APARs VM65930 and VM65982, the z/VM RACF Security Server feature supports the following security policy enhancements:
  - Read-Only Auditor (ROAUDIT): This new user role allows many of the common auditing tasks to be performed without the ability to modify settings or manipulate audit logs.

  - XAUTOLOG..ON control: This enhancement introduces new security policy requirements for the ON operand of the CP XAUTOLOG command. This changes default behavior of this operand when an ESM is installed on your system.
  - List the current VMXEVENT profile: This enhancement updates the SETEVENT LIST command to provide an authorized user with the names of the VMXEVENT profiles activated and in use by RACF.

    **Note:** The PTF for APAR VM65923 provides infrastructure support in z/VM V6.2, V6.3, and V6.4 and must be installed on all the members of an SSI cluster before any V6.4 member is running with the PTF for APAR VM65930.

- ***Crypto Express APVIRT support for the z/VM TLS/SSL server and LDAP/VM:*** With the available PTF for APAR PI72106, the z/VM System SSL cryptographic library is updated to offload cryptographic operations to Crypto Express hardware associated with your IBM LinuxONE hardware, which may improve performance. This support is intended for clear-key RSA operations. To enable this support, add the CRYPTO APVIRTUAL statement to the pertinent service virtual machine entries in the z/VM User Directory.
- ***EAV minidisk support:*** With the PTFs for APARs VM65943, VM65945, and PI85943, enhanced EAV support for 3390-A DASD devices supporting 28-bit cylinder addresses is provided. This support will allow non-fullpack minidisks to reside anywhere on the volume, including beyond the current restriction of the 64K cylinder boundary (0-65519), and up to the one terabyte limit currently supported.
- ***Dump processing enhancements:*** With the available PTF for APAR VM65989, the amount of time it takes for z/VM to write a hard abend or snap dump to 3390 DASD may be reduced. The improvements were achieved via changes to the I/O channel program used to write central memory to z/VM spool space located on 3390 DASD. This APAR also provides support for reducing dump size by excluding PGMBKs from snap dumps.
- ***Alternate Subchannel Set Dynamic I/O support:*** With the available PTF for APAR VM65942, z/VM V6.4 provides dynamic I/O commands within the z/VM hypervisor for supporting define, modify, and delete of a device within either the default or alternate subchannel sets. HCD support is currently not available.

***STP - Time synchronization***

Server Time Protocol (STP) is designed to allow events occurring in different servers to be properly sequenced in time. STP is for servers which need time synchronization. STP is a server-wide facility that is implemented in the Licensed Internal Code (LIC), presenting a single view of time to Processor Resource/Systems Manager™ (PR/SM). The STP design introduced a concept called Coordinated Timing Network (CTN), a collection of servers that are time-synchronized to a time value called Coordinated Server Time.

**STP enhancements:** IBM z14 introduced an additional stratum level 4 for Server Time Protocol (STP) synchronization which is also available on IBM Emperor II. With the additional stratum level, STP can synchronize systems up to 3 steps away from the Current Time Server (CTS). Prior systems allowed synchronization only up to level 3, or up to 2 steps from the CTS. This additional stratum level is not intended for long-term use; rather, it is specifically intended for short-term use during configuration changes for large timing networks, to avoid some of the cost and complexity caused by being constrained to a 3-stratum timing configuration. IBM z14 also introduced a new Graphical User Display for the STP network and configuration, which is also available on IBM Emperor II. The new user interface has been revamped for a quick, intuitive view of the various pieces of the STP relationship network map, including the status of the components of the timing network. The new support allows the new level of HMC to manage older systems using the same new interface.

***Hardware Management Console (HMC)***

**HMC/SE user interface:** The Emperor II Hardware Management Console and Support Element will support only the Tree Style user interface. The Classic Style user interface is no longer supported.

The following enhancements have been made to the Tree Style user interface to aid with new users of Tree Style as well as address pain points of existing users.

- A new Masthead with Favorites and Search controls will help users quickly find and launch tasks.
- Tasks will now open in tabs within the user interface (instead of separate browser windows) to make finding and managing running tasks easier.
- There is also the ability to have the task tab "pop-out" into a separate window, giving users the ability to have a similar parallel task display window as on previous Tree Style controls and allowing the task displays to be viewed on other physical displays.

**Manage System Time:** The Manage System Time task replaces the System Time task on HMC. The new Manage System Time task provides a simplified workflow for system time management including:

- Improved help tools to complement and improve system administrator skills:
  - Inline definition of technical terms.
- Improved user experience with visual representation of configuration panels:
  - Guidance provided within the workflows.
  - Topology displays of system time networks.
  - Errors surfaced in visualization for easier problem resolution of setup errors.
- Single point of system time management for multiple systems.

**IBM Hardware Management Console (HMC) 2.14.0 security enhancements:** New security features in the Hardware Management Console (HMC) 2.14.0 available with IBM Emperor II include Multifactor Authentication, Firmware Integrity Monitoring in support of NIST Standard 800-147B, Crypto Compliance Levels, FTP through HMC, Secure Console to Console Communication Enhancements, Remote Browser IP Address Limiting, and more.

- **Multifactor Authentication:** The Hardware Management Console will now offer an optional control of Multifactor Authentication in addition to the userid/password controls provided today. If the Multifactor option is selected for a given user, that user will now be required to enter a second authentication factor using a TOTP (Time-based One-Time Password) defined by RFC 6238. RFC 6238 is implemented by freely available smartphone and web apps utilizing a secret key provided per HMC user.
- **HMC Mobile for Z and LinuxONE:** New iOS and Android mobile apps are planned to be available for the HMC 2.14.0 supporting Emperor II, z14, z13™, LinuxONE Emperor, and LinuxONE Rockhopper systems. HMC Mobile will help enable HMC users to securely monitor and manage systems from anywhere. The apps provide system and partition views, status monitoring, hardware messages, operating system messages, and the ability to receive push notifications from the HMC using the existing zRSF (IBM Z Remote Support Facility) connection. HMC Mobile is disabled by default and, once enabled, provides a robust set of security controls. Administrators can restrict usage to specific HMC users and IP addresses, require the use of app passwords, enable Multifactor Authentication, restrict the app to read-only access, and more.
- **Firmware integrity monitoring:** Emperor II will also offer an enhancement on the Support Element that provides notification if tampering with booting of firmware on the server (CPC) is detected. This enhancement is designed to meet the BIOS Protection Guidelines recommended and published by the National Institute of Standards and Technology (NIST) in Special Publication 800-147B. If tampering is detected, the Support Element will issue a customer alert via a warning or a lock of the Support Element, depending on the configuration. If "call home" support is enabled on an Emperor II Hardware Management Console managing the Support Element, additional analysis of the Support Element will be performed and displayed by IBM Resource Link®.

In addition to this support, the Hardware Management Console also has been enhanced to provide attempted tamper monitoring and reporting. A newly manufactured Hardware Management Console directly ordered with Emperor II, or at a later time, is required for this protection. Any detected events of attempted tampering will be logged and will issue a customer alert via a warning or a lock of the Hardware Management Console, depending on setup configuration. In addition, if "call home" support is enabled on the Hardware Management Console, supplementary analysis of events logged by the Hardware Management Console will be available on IBM Resource Link.

Although customers can carry forward their Hardware Management Consoles on Emperor II, these tamper protection capabilities will be delivered only on newly manufactured Hardware Management Consoles. The Emperor II environment can contain both Hardware Management Consoles that have been carried forward and newly manufactured Hardware Management Consoles.

**IBM Enhanced Remote Support Facility:** The IBM Enhanced Remote Support Facility was first introduced on zEC12/zBC12 systems and for those systems, z13/z13s, and LinuxONE Emperor/LinuxONE Rockhopper, both the Enhanced and Legacy Remote Support Facility support could be utilized. The Enhanced support provided improved problem data uploads and fix data downloads. z14 and Emperor II processors will no longer connect to the legacy IBM Support Facility.

- z14 and Emperor II HMCs supporting older z10EC/z10BC -z13 systems will still require connections to the legacy IBM Support Facility.
- z14 and Emperor II HMCs supporting only z14 or Emperor II systems only require IBM Enhanced Support Facility connections.
- A connection to the IBM Enhanced Support Facility is required to support z14 and Emperor II HMCs regardless of the CPC they are supporting.

If you had not previously configured firewalls and proxy support with the ability to connect to the Enhanced Support Facility, this will be required for Emperor II and z14 HMC and CPC connections per above rules.

**Global OSA/SF:** The HMC Global OSA/SF will now provide a global view of all OSA PCHIDs and the monitoring and diagnostic information previously available in the Query Host command.

**New characters supported for Load parms:** Starting with z14 and Emperor II the Load parameter for Load task, Activation Load, and Image Profiles will now allow three new characters: @#$. z13/z13s or older systems support a character set of A-Z, 0-9, "." (period), and " " (blanks). Emperor II systems will support a character set of A-Z, 0-9, "." (period), " " (blanks), "@", "#", and "$".

**FTP through HMC:** To maximize security features, IBM recommends that customers keep their IBM LinuxONE server on a dedicated network with one HMC network used for that network and the second HMC network used for outward communication (IBM Support Facility, remote browsing, automation). However, for systems prior to z14, this created a security challenge for FTP operations originating from the SE. Customers have to either put their FTP server on the IBM LinuxONE dedicated network or put their IBM LinuxONE on their intranet network.

Starting with z14 and Emperor II, all FTP operations originating from the SE will be proxied through a managing HMC. This now allows the FTP SE originated operations to follow IBM security recommendations. In addition, all HMC/SE tasks that support FTP will provide three options of FTP: FTP, FTPS, and SFTP.

- FTPS is SSL based and uses certificates to authenticate servers.
- SFTP is SSH based and uses SSH keys to authenticate servers.
- Username and passwords are required for client authentication in all three protocols.

**Console to console communications:** HMC consoles have used anonymous cipher suites for some inter-console communication purposes. These cipher suites, while providing encryption and integrity validation, do not provide cryptographic

authentication. Network security scanners can detect this, and anonymous cipher suites may not be acceptable to some customers' security policies. Starting with z14 and Emperor II HMC/SE, the console to console communications solution, when security is enabled, will no longer use anonymous cipher suites and will begin using an industry standard based password driven cryptography system. This system provides cryptographic encryption, integrity validation, and authentication.

**Removal of Common Infrastructure Module (CIM) Management Interface:** The HMC 2.14.0 will no longer support the Hardware Console Common Infrastructure Module (CIM) Management Interface. The Hardware Management Console Simple Network Management Protocol (SNMP), and Web Services Application Programming Interfaces (APIs) will continue to be supported.

### Accessibility by people with disabilities

A US Section 508 Voluntary Product Accessibility Template (VPAT) containing details on accessibility compliance can be found on the IBM Accessibility website.

## Product positioning

Commonly referred to as the oil of our era, data has become the new global currency. IT today is experiencing a time of exponential growth in the sheer volumes of data, fueled by the digital transformation of systems, services, and interconnected devices that all require strong data serving capabilities. Businesses must be able to manage, store, and protect this information, and, most important, use it for competitive advantage. This is creating the demand to apply intelligence and insight to the data to build new services wrapped for a customized user experience. From a user perspective, IT must create an environment where users have confidence that data is protected yet available from anywhere and any device. This ability to be fast and flexible in delivery of new services, with insight and security, will differentiate a business. The IBM Emperor II delivers unique capabilities to help with that differentiation.

At the core of every enterprise lies core business data, assets which if lost or compromised could cause irreparable damage. Core business data is often governed by regulatory requirements designed to protect data and safeguard privacy, with high penalties in the event of loss or inadvertent disclosure. Internal and external pressures to protect customer data have changed the perspective around how core business data should be handled and protected. Establishing a "perimeter" around core data using encryption is one of the most impactful ways to protect data and prevent loss. The objective is to create a fortified perimeter around core business data, wherever it may physically reside. The Emperor II platform provides pervasive encryption capabilities designed to enable you to protect data efficiently, and without requiring application changes, making it the world's premier system for enabling encryption of data as the new perimeter across the value chain.

The security capabilities of Emperor II are unmatched in the industry. The Emperor II platform provides the hardware infrastructure, in a balanced system design, with the encryption capabilities that now make it possible to create a fortified perimeter around critical business data. Security is built into the Emperor II hardware, enabling lightning fast hardware encryption of all data whether it is in use, in flight, or at rest. This is achieved without having to make changes to applications. IBM's unique Secure Service Container technology helps protect client data from both external and internal threats and is designed to offer the highest security level available for protected key management (FIPS 140-2 level 4). Ultimate workload isolation and encryption though the IBM Secure Service Container provides a virtual lock box for each workload. The use of protected keys helps to secure data without giving up performance and industry-leading secure Java performance via SSL is 2 to 3 times faster than x86 alternatives. Instead of only protecting a selective 4% of data as is common with x86 clouds, Emperor II protects 100% through pervasive encryption, all with zero application changes, and minimal operational overhead, which helps improve efforts to meet various regulatory requirements. Pervasive encryption allows application development to focus on innovation rather

than application-level encryption.This leading innovation in security and other technologies is a reason why the 10 largest global insurers, 70 percent of the world's largest retailers, 23 of the 25 largest airlines, and 92 of the top 100 banks worldwide have placed their trust in IBM.

The Emperor II provides the infrastructure to meet the demands of a digital business. With up to 170 configurable cores, Emperor II has performance and scaling advantages over prior generations, and more capacity than the original Emperor 141-way. With capacity to do the work of hundreds or in many cases thousands of x86 servers in a single footprint, Emperor II has a 3-year running cost below x86(1). Massive memory and I/O bandwidth has been built into the system to support fast in-memory workloads and real-time analytics that bring more insights and new business value.

Emperor II provides unrivaled performance and vertical scale to support larger workloads with less latency and less admin complexity. Vertical scale allows Emperor II to scale up to 2 million Docker containers in a single system(2). As a system engineered for data-serving workloads, Emperor II can move data faster than alternative platforms(3). It has a 2.1x higher throughput, can serve up to 30 billion web data requests a day, and has the ability to host 20x larger databases without the added cost and latency of fragmenting data across server farms(3). There are 640 additional processors that are not part of the general processor count. These additional processors are solely dedicated to I/O processing to help increase I/O speeds and to help assure data integrity, all with zero additional licensing costs. On x86 this work is done with standard processors that drive incremental hardware, software, and administrative costs. Emperor II is the only Linux system that offers this built-in fast I/O subsystem capable of over 190K 8K read IOPs per FCP link.

With up to 32 TB of real memory, Emperor II can open opportunities such as in-memory data marts, large buffer pools for data access, and in-memory analytics while giving you the necessary room to tune applications for optimal performance. More data in memory means more efficient, cost-effective vertical scaling while maintaining a real-time single source of the truth. Advancements such as SIMD accelerate analytic workloads and decimal compute, which are vital to financial applications. Java improvements such as pause-less garbage collection enable vertical scaling while maintaining predictable results. The use of crypto acceleration will deliver additional improvements in throughput per core, which gives a natural boost to Java processes.

As a shared, immutable ledger for recording the history of transactions, Blockchain is a revolutionary technology that is transforming business around the globe. It allows all members of a supply chain to share a digital ledger that is updated every time a transaction occurs. Members can view ledger progress in a common, transparent, and accessible record. Cryptographic privacy ensures that members only see the parts of the ledger relevant to them, and that transactions are secure, authenticated, and verifiable. Businesses and customers around the globe need to interface with each other to exchange assets such as currency, services, and information. Experts believe that Blockchain will do for transactions what the internet did for information. As a highly engineered platform designed for secure, data-serving workloads, IBM chose Emperor II to run the IBM Blockchain Platform. Blockchain is expected to radically improve the operational effectiveness of businesses around the globe by enabling more data points, quicker responses, increased trust, and tamper-proof records. Emperor II is the cornerstone of the IBM Blockchain offering.

IBM has been committed to Linux for decades and continues to invest in the Linux ecosystem. Emperor II provides a unique platform for any Linux solution requiring high availability, security features, or scalability and supports a wealth of new open source products such as Go, Python, Scala, Node.js, Docker, Spark, MongoDB, PostgreSQL, and MariaDB. Emperor II adds to IBM's commitment by allowing clients to take advantage of transformative technologies like Blockchain, gain cognitive insights through the use of Spark analytics, scale vertically with unmatched speed, provide highly secure data-serving capabilities, and leverage the use of application programming interfaces (APIs) to help create and deliver innovative, new customer services.

(1) Price comparison estimates based on a 3-year Total Cost of Ownership (TCO) using publicly available US prices (current as of January 1, 2016). Public Cloud TCO estimate includes costs (US East Region) of infrastructure (instances, data out, storage, support, free tier/reserved tier discounts), middleware, and labor. z13s and x86 TCO estimates include costs of infrastructure (system, memory, storage, virtualization, OS), middleware, and labor. Results may vary based on actual workloads, system configurations, customer applications, queries, and other variables in a production environment and may produce different results. Users of this document should verify the applicable data for their specific environment.

(2) Performance result is extrapolated from IBM internal tests running in a z14 LPAR with 10 dedicated IFLs and 16 GB memory 1000 BusyBox Docker containers with ApacheHTTP. Results may vary. Operating system was SLES 12 SP2 (SMT mode). Docker 1.12 was used.

(3) Performance comparison based on IBM internal tests comparing IBM z13s with one comparably configured x86 environment and one comparably configured public cloud running general purpose virtual machines designed to replicate typical IBM customer workload usage in the marketplace. System configurations are based on equivalence ratios derived from IBM internal studies and are as follows: Public Cloud configuration: total of 24 general purpose instances; x86 configuration: total of two x86 systems each with 24 Intel™ E5-2690 v3 cores, 192 GB memory, and 2x400 GB SSDs; z13s configuration: total of 8 cores, 384 GB memory, and Storwize® v7000 with 4x400 GB SSDs.

## Statement of general direction

**Stabilization of z/VM V6.3 support:** IBM Emperor II is planned to be the last IBM LinuxONE server and IBM Rockhopper is planned to be the last midrange IBM LinuxONE server supported by z/VM V6.3 and the last IBM LinuxONE servers that will be supported when z/VM V6.3 is running as a guest. z/VM V6.3 will continue to be supported until December 31, 2017, as announced in Withdrawal Announcement ZP15-0054, dated February 03, 2015.

**Future z/VM release guest support:** z/VM V6.4 will be the last z/VM release supported as a guest of z/VM V6.2 or older releases.

**Disk-only support for z/VM dumps:** z/VM V6.4 will be the last z/VM release to support tape as a media option for stand-alone, hard abend, and snap dumps. Subsequent releases will support dumps to ECKD™ DASD or FCP SCSI disks only.

**Dynamic Partition Manager support of ECKD:** IBM intends to deliver support for adding and configuring ECKD FICON® disks to partitions created in Dynamic Partition Manager (DPM) mode for Linux running in an LPAR, under KVM for IBM Z, and under z/VM V6.4.

**Extension of the IBM Secure Service Container framework:** IBM intends to extend the IBM Secure Service Container framework and make it available to external users to enable the development of container-based applications, on premises, with industry-leading container orchestration, enabling users to seamlessly integrate the mainframe with their enterprise-wide DevOps and container strategy. An IBM Secure Service Container beta program is planned to be available. See the IBM Secure Service Container website for additional information and prerequisites, and to apply for the program.

IBM's statements regarding its plans, directions, and intent are subject to change or withdrawal without notice at IBM's sole discretion. Information regarding potential future products is intended to outline our general product direction and it should not be relied on in making a purchasing decision. The information mentioned regarding potential future products is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. Information about potential future products may not be incorporated into any contract. The development, release, and timing of any future features or functionality described for our products remain at our sole discretion.

## Reference information

For more information about the IBM z13™, refer to Hardware Announcement ZG15-0001, dated January 14, 2015.

For more information about Software withdrawal and support discontinuance: IBM z Systems™ platform selected products, refer to Withdrawal Announcement ZP15-0054, dated February 03, 2015.

For more information on the IBM z13s and IBM LinuxONE, refer to Hardware Announcement ZG16-0002, dated February 16, 2016.

For more information on the Enhanced support for shipping of IBM z13 and z13s servers, refer to Hardware Announcement ZG16-0078, dated June 07, 2016.

For more information about the z/VM V6.4, refer to Software Announcement ZP16-0111, dated October 25, 2016.

For more information about Sub-capacity pricing terms for z/VM and z/VM-based programs, refer to Software Announcement ZP17-0346, dated July 17, 2017.

For more information about IBM z14, refer to Hardware Announcement ZG17-0017, dated July 17, 2017.

## Product number

| Description | Machine type | Model | Feature |
|---|---|---|---|
| IBM Emperor II | 3906 | LM1 | |
| | | LM2 | |
| | | LM3 | |
| | | LM4 | |
| | | LM5 | |
| MTU 1 --D | | | 0001 |
| MTU 100 --D | | | 0002 |
| MTU 1 --V | | | 0003 |
| MTU 100 --V | | | 0004 |
| GTU 1 -D | | | 0005 |
| GTU 100 -D | | | 0006 |
| GTU 1 -V | | | 0007 |
| GTU 100 -V | | | 0008 |
| GTU 1000 -D | | | 0009 |
| GTU 1000 -V | | | 0010 |
| | | | |
| HW for DPM | | | 0016 |
| Customized MRReport | | | 0017 |
| RPQ Cost Analysis Sizing | | | 0018 |
| Migration Offering Machine | | 0014 | |
| HMC | | 0082 | |
| HMC Rack Mount | | 0083 | |
| TKE Rack Mount w/4768 | | 0085 | |
| TKE w/4768 | | 0086 | |
| WWPN Persistence | | 0099 | |
| Mouse | | 0152 | |
| HMC Tower Keyboard | | 0153 | |
| HMC Rack Keybd/Monitor/Mouse | | 0154 | |

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|---|---|
| TKE Tower Keyboard | 0155 |
| TKE Rack Keybd/Monitor/Mouse | 0156 |
| Client Must Provide Mouse | 0186 |
| Client Must Provide HMC Keybd | 0187 |
| Client Must Provide HMC KMM | 0188 |
| Client Must Provide TKE Keybd | 0189 |
| Client Must Provide TKE KMM | 0190 |
| Client Must Provide Display | 0191 |
| | |
| 1 CPE Capacity Unit-IFL | 0119 |
| 100 CPE Capacity Unit-IFL | 0120 |
| 1 CPE Capacity Unit-SAP | 0127 |
| 100 CPE Capacity Unit-SAP | 0128 |
| | |
| A Fr Radiator | 4029 |
| A Fr Water | 4030 |
| Air w/o TEIO & w/o HtrR | 0072 |
| Air w/o TEIO & w/HtR | 0073 |
| Air w/TEIO & w/o HtR | 0074 |
| Air w/TEIO & w/HtR | 0075 |
| Wat w/o TEIO & w/o HtrR | 0076 |
| Wat w/o TEIO & w/ HtR | 0077 |
| Wat w/TEIO & w/o HtR | 0078 |
| Wat w/TEIO & w/HtR | 0079 |
| Air w/o TEIO & w/o HtrR | 0105 |
| Air w/o TEIO & w/HtR | 0106 |
| Air w/TEIO & w/o HtR | 0107 |
| Air w/TEIO & w/HtR | 0108 |
| Wat w/o TEIO & w/o HtrR | 0109 |
| Wat w/o TEIO & w/HtR | 0110 |
| Wat w/TEIO & w/o HtR | 0111 |
| Wat w/TEIO & w/HtR | 0112 |
| Standard Cover Set | 0160 |
| | |
| Fanout Airflow GX++ | 0165 |
| PCIe Fanout | 0173 |
| Fanout Airflow PCIe | 0174 |
| | |
| Manage FW Suite | 0019 |
| Automate FW Suite | 0020 |
| Ensemble membership | 0025 |
| | |
| PCIe Interconnect | 0401 |
| 10 GbE RoCE Express2 | 0412 |
| OSA-Express6S GbE LX | 0422 |
| OSA-Express6S GbE SX | 0423 |
| OSA-Express6S 10 GbE LR | 0424 |
| OSA-Express6S 10 GbE SR | 0425 |
| OSA-Express6S 1000BASE-T | 0426 |
| FICON Express16S+ LX | 0427 |
| FICON Express16S+ SX | 0428 |
| zEDC Express(R) | 0420 |
| Read Only Media Option | 0845 |
| TKE Addl Smart Cards | 0892 |
| 32GB USB Backup Media | 0848 |
| TKE 9.0 LIC | 0879 |

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|---|---|
| TKE Smart Card Reader | 0891 |
| Crypto Express6S | 0893 |
| RFID Tag | 0035 |
| RFID Tag | 0036 |
| RFID Tag | 0037 |
| UID Label for DoD | 0998 |
| STP Enablement | 1021 |
| EMEA Special Operations | 1022 |
| | |
| 32 GB Mem DIMM(5/feat) | 1627 |
| 64 GB Mem DIMM(5/feat) | 1628 |
| 128 GB Mem DIMM(5/feat) | 1629 |
| 256 GB Mem DIMM(5/feat) | 1630 |
| 512 GB Mem DIMM(5/feat) | 1631 |
| | |
| LICCC Ship Via Net Ind | 1750 |
| 64GB Memory Capacity Incr | 1893 |
| 256GB Memory Capacity Incr | 1894 |
| 32GB Memory Capacity Incr | 1898 |
| 32GB Memory Capacity Incr >1TB | 1938 |
| 64GB Memory Capacity Incr >1TB | 1939 |
| 256GB Memory Capacity Incr >1TB | 1940 |
| 32GB Preplanned memory | 1990 |
| 64GB Preplanned Memory | 1991 |
| Line Cord Plan Ahead | 2000 |
| | |
| 256 GB Memory | 1660 |
| 320 GB Memory | 1661 |
| 384 GB Memory | 1662 |
| 448 GB Memory | 1663 |
| 512 GB Memory | 1664 |
| 576 GB Memory | 1665 |
| 704 GB Memory | 1666 |
| 832 GB Memory | 1667 |
| 960 GB Memory | 1668 |
| 1088 GB Memory | 1669 |
| 1216 GB Memory | 1670 |
| 1344 GB Memory | 1671 |
| 1472 GB Memory | 1672 |
| 1600 GB Memory | 1673 |
| 1856 GB Memory | 1674 |
| 2112 GB Memory | 1675 |
| 2368 GB Memory | 1676 |
| 2624 GB Memory | 1677 |
| 2880 GB Memory | 1678 |
| 3136 GB Memory | 1679 |
| 3392 GB Memory | 1680 |
| 3648 GB Memory | 1681 |
| 3904 GB Memory | 1682 |
| 4416 GB Memory | 1683 |
| 4928 GB Memory | 1684 |
| 5440 GB Memory | 1685 |
| 5952 GB Memory | 1686 |
| 6464 GB Memory | 1687 |
| 6976 GB Memory | 1688 |
| 7488 GB Memory | 1689 |

| | |
|---|---|
| 8000 GB Memory | 1690 |
| | |
| US English | 0235 |
| France | 0236 |
| German/Austrian | 0237 |
| LA Spanish | 0238 |
| Spain | 0239 |
| Italian | 0240 |
| French Canadian | 0241 |
| Portuguese | 0242 |
| UK English | 0243 |
| Norwegian | 0244 |
| Sweden Finland | 0245 |
| Netherlands | 0246 |
| Belgian French | 0247 |
| Denmark | 0248 |
| Swiss French/German | 0249 |
| | |
| Flat Panel Display | 6096 |
| Balanced Power Plan Ahead | 3003 |
| BPD Pair | 3014 |
| BPR Pair | 3015 |
| Internal Battery IBF | 3216 |
| Universal Lift Tool Upg Kit | 3103 |
| Universal Lift Tool/Ladder | 3105 |
| FDT Adapter Kit | 3379 |
| Fill and Drain Kit | 3380 |
| | |
| Serv Docs Optional Print | 0033 |
| CPACF Enablement | 3863 |
| PCIe I/O Drawer | 4013 |
| | |
| 14ft Water Hose | 7801 |
| FQC Bracket & Mounting Hdw | 7923 |
| LC Duplex 6.6 ft Harness | 7924 |
| LC Duplex 8.5ft Harness | 7925 |
| LC Duplex 12 ft Harness | 7926 |
| Top Exit I/O Cabling | 7942 |
| Side Covers | 7949 |
| Non Raised Floor Support | 7998 |
| 4-in-1 Bolt Down Kit | 8003 |
| 3-in-1 Bolt Down Kit-W | 8004 |
| Bolt Down Kit, NRF | 8005 |
| 14 ft 380-520V DC Cut TE Cord | 8948 |
| 14 ft LoV 3PH Cut TE Cord | 8949 |
| 14 ft. HiV 3PH Cut TE Cord | 8951 |
| 14 ft 380-520V DC Cut Cord | 8965 |
| 14 ft LoV 3PH Cut Line Cord | 8982 |
| 14 ft. HiV 3PH Cut Line Cord | 8988 |
| 14 ft 200-240V 3PH Cut-LSZH | 8996 |
| 14 ft HiV 3PH Cut Line-LSZH | 8998 |

| | | | |
|---|---|---|---|
| Non RSF On/Off CoD | | | 0032 |
| Multi Order Ship Flag | | | 9000 |
| Multi Order Rec Only Flag-NB | | | 9001 |

| | | | |
|---|---|---|---|
| Multi Order Rec Only Flag-MES | | | 9002 |
| RPO Action Flag | | | 9003 |
| Downgraded PUs Per Request | | | 9004 |
| On/Off CoD 100 IFL Days | | | 9874 |
| On/Off CoD 100 SAP Days | | | 9878 |
| On/Off CoD Act IFL Day | | | 9888 |
| On/Off CoD authorization | | | 9896 |
| Perm upgr authorization | | | 9898 |
| CIU Activation (Flag) | | | 9899 |
| On-Line CoD Buying (Flag) | | | 9900 |
| On/Off CoD Act SAP Day | | | 9909 |
| CBU authorization | | | 9910 |
| CPE authorization | | | 9912 |
| OPO Sales authorization | | | 9913 |
| 1 MSU day | | | 9917 |
| 100 MSU days | | | 9918 |
| 10000 MSU days | | | 9919 |
| 1 IFL day | | | 9920 |
| 100 IFL days | | | 9921 |
| 1 SAP day | | | 9928 |
| 100 SAP days | | | 9929 |
| Weight Distribution Kit | | | 9970 |
| Height Reduce Ship | | | 9975 |
| Height reduce for return | | | 9976 |
| CP4 | | | 1929 |
| IFL | | | 1933 |
| SAP (optional) | | | 1935 |
| Unassigned IFL | | | 1937 |
| | | | |
| Additional CBU Test | | | 6805 |
| Total CBU Years Ordered | | | 6817 |
| CBU Records Ordered | | | 6818 |
| Single CBU IFL Year | | | 6822 |
| 25 CBU IFL Year | | | 6823 |
| Single CBU SAP Year | | | 6830 |
| 25 CBU SAP Year | | | 6831 |
| CBU Replenishment | | | 6832 |
| Capacity for Planned Event | | | 6833 |
| OPO Sales Flag | | | 6835 |

| | | | |
|---|---|---|---|
| OPO Sales Flag Alteration | | | 6836 |
| | | | |
| 0-Way Processor CP4 | | | 2001 |
| 1-Way Processor CP4 | | | 2002 |
| | | | |
| 400 Capacity Marker | | | 2519 |
| 401 Capacity Marker | | | 2520 |
| | | | |
| IBM Emperor II | 3906 | LM1 | |
| Model LM1 Air Cooled | | | 1107 |
| Model LM1 Water Cooled | | | 1112 |
| | | | |
| IBM Emperor II | 3906 | LM2 | |
| Model LM2 Air Cooled | | | 1108 |
| Model LM2 Water Cooled | | | 1113 |
| | | | |
| IBM Emperor II | 3906 | LM3 | |
| Model LM3 Air Cooled | | | 1109 |
| Model LM3 Water Cooled | | | 1114 |
| | | | |
| IBM Emperor II | 3906 | LM4 | |
| Model LM4 Air Cooled | | | 1110 |
| Model LM4 Water Cooled | | | 1115 |
| | | | |
| IBM Emperor II | 3906 | LM5 | |
| Model LM5 Air Cooled | | | 1111 |
| Model LM5 Water Cooled | | | 1116 |
| | | | |
| IBM Emperor II | 3906 | LM2 | |
| | | LM3 | |
| | | LM4 | |
| | | LM5 | |
| 8512 GB Memory | | | 1691 |
| 9024 GB Memory | | | 1692 |
| 9536 GB Memory | | | 1693 |
| 10048 GB Memory | | | 1694 |
| 10560 GB Memory | | | 1695 |
| 11072GB Memory | | | 1696 |
| 11584 GB Memory | | | 1697 |
| 12096 GB Memory | | | 1698 |
| 12608 GB Memory | | | 1699 |
| 13120 GB Memory | | | 1700 |
| 13632 GB Memory | | | 1701 |
| 14144 GB Memory | | | 1702 |
| 14656 GB Memory | | | 1703 |

| | | | |
|---|---|---|---|
| 15168 GB Memory | | | 1704 |
| 15680 GB Memory | | | 1705 |
| 16192 GB Memory | | | 1706 |
| IBM Emperor II | 3906 | LM3 | |
| | | LM4 | |
| | | LM5 | |
| 16704 GB Memory | | | 1707 |
| 17216 GB Memory | | | 1708 |
| 17728 GB Memory | | | 1709 |
| 18240 GB Memory | | | 1710 |
| 18732 GB Memory | | | 1711 |
| 19264 GB Memory | | | 1712 |
| 19776 GB Memory | | | 1713 |
| 20288 GB Memory | | | 1714 |
| 20800 GB Memory | | | 1715 |
| 21312 GB Memory | | | 1716 |
| 21824 GB Memory | | | 1717 |
| 22336 GB Memory | | | 1718 |
| 22848 GB Memory | | | 1719 |
| 23360 GB Memory | | | 1720 |
| 23872 GB Memory | | | 1721 |
| 24384 GB Memory | | | 1722 |
| IBM Emperor II | 3906 | LM4 | |
| | | LM5 | |
| 24896 GB Memory | | | 1723 |
| 25408 GB Memory | | | 1724 |
| 25920 GB Memory | | | 1725 |
| 26432 GB Memory | | | 1726 |
| 26944 GB Memory | | | 1727 |
| 27456 GB Memory | | | 1728 |
| 27968 GB Memory | | | 1729 |
| 28480 GB Memory | | | 1730 |
| 28992 GB Memory | | | 1731 |
| 29504 GB Memory | | | 1732 |
| 30016 GB Memory | | | 1733 |
| 30528 GB Memory | | | 1734 |
| 31040 GB Memory | | | 1735 |
| 31552 GB Memory | | | 1736 |
| 32064 GB Memory | | | 1737 |
| 32576 GB Memory | | | 1738 |

## Model conversions

| From Machine type | From Model | To Machine type | To Model | | Description |
|---|---|---|---|---|---|
| 3906 | LM1 | 3906 | LM2 | (*) | LM1 to LM2 |
| 3906 | LM1 | 3906 | LM3 | (*) | LM1 to LM3 |
| 3906 | LM1 | 3906 | LM4 | (*) | LM1 to LM4 |
| 3906 | LM1 | 3906 | M01 | (*) | LM1 to M01 |
| 3906 | LM1 | 3906 | M02 | (*) | LM1 to M02 |
| 3906 | LM1 | 3906 | M03 | (*) | LM1 to M03 |

| From Machine type | From Model | To Machine type | To Model | | Description |
|---|---|---|---|---|---|
| 3906 | LM1 | 3906 | M04 | (*) | LM1 to M04 |
| 3906 | LM2 | 3906 | LM3 | (*) | LM2 to LM3 |
| 3906 | LM2 | 3906 | LM4 | (*) | LM2 to LM4 |
| 3906 | LM2 | 3906 | M02 | (*) | LM2 to M02 |
| 3906 | LM2 | 3906 | M03 | (*) | LM2 to M03 |
| 3906 | LM2 | 3906 | M04 | (*) | LM2 to M04 |
| 3906 | LM3 | 3906 | LM4 | (*) | LM3 to LM4 |
| 3906 | LM3 | 3906 | M03 | (*) | LM3 to M03 |
| 3906 | LM3 | 3906 | M04 | (*) | LM3 to M04 |
| 3906 | LM4 | 3906 | M04 | (*) | LM4 to M04 |
| 3906 | LM5 | 3906 | M05 | (*) | LM5 to M05 |

(*) Parts removed as a result of model conversions become the property of IBM.

**Feature conversions**

| From Machine type | From FC | To Machine type | To FC | | Description |
|---|---|---|---|---|---|
| 3906 | 1107 | 3906 | 1108 | (*) | LM1 air to LM2 air |
| 3906 | 1107 | 3906 | 1109 | (*) | LM1 air to LM3 air |
| 3906 | 1107 | 3906 | 1110 | (*) | LM1 air to LM4 air |
| 3906 | 1107 | 3906 | 1023 | (*) | LM1 air to M01 air |
| 3906 | 1107 | 3906 | 1024 | (*) | LM1 air to M02 air |
| 3906 | 1107 | 3906 | 1025 | (*) | LM1 air to M03 air |
| 3906 | 1107 | 3906 | 1026 | (*) | LM1 air to M04 air |
| 3906 | 1108 | 3906 | 1109 | (*) | LM2 air to LM3 air |
| 3906 | 1108 | 3906 | 1110 | (*) | LM2 air to LM4 air |
| 3906 | 1108 | 3906 | 1024 | (*) | LM2 air to M02 air |
| 3906 | 1108 | 3906 | 1025 | (*) | LM2 air to M03 air |
| 3906 | 1108 | 3906 | 1026 | (*) | LM2 air to M04 air |
| 3906 | 1109 | 3906 | 1110 | (*) | LM3 air to LM4 air |
| 3906 | 1109 | 3906 | 1025 | (*) | LM3 air to M03 air |
| 3906 | 1109 | 3906 | 1026 | (*) | LM3 air to M04 air |

| From Machine type | From FC | To Machine type | To FC | | Description |
|---|---|---|---|---|---|
| 3906 | 1110 | 3906 | 1026 | (*) | LM4 air to M04 air |
| 3906 | 1111 | 3906 | 1027 | (*) | LM5 air to M05 air |
| 3906 | 1112 | 3906 | 1113 | (*) | LM1 water to LM2 water |
| 3906 | 1112 | 3906 | 1114 | (*) | LM1 water to LM3 water |
| 3906 | 1112 | 3906 | 1115 | (*) | LM1 water to LM4 water |
| 3906 | 1112 | 3906 | 1028 | (*) | LM1 water to M01 water |
| 3906 | 1112 | 3906 | 1029 | (*) | LM1 water to M02 water |
| 3906 | 1112 | 3906 | 1030 | (*) | LM1 water to M03 water |
| 3906 | 1112 | 3906 | 1031 | (*) | LM1 water to M04 water |
| 3906 | 1113 | 3906 | 1114 | (*) | LM2 water to LM3 water |
| 3906 | 1113 | 3906 | 1115 | (*) | LM2 water to LM4 water |
| 3906 | 1113 | 3906 | 1029 | (*) | LM2 water to M02 water |
| 3906 | 1113 | 3906 | 1030 | (*) | LM2 water to M03 water |
| 3906 | 1113 | 3906 | 1031 | (*) | LM2 water to M04 water |
| 3906 | 1114 | 3906 | 1115 | (*) | LM3 water to LM4 water |
| 3906 | 1114 | 3906 | 1030 | (*) | LM3 water to M03 water |
| 3906 | 1114 | 3906 | 1031 | (*) | LM3 water to M04 water |
| 3906 | 1115 | 3906 | 1031 | (*) | LM4 water to M04 water |
| 3906 | 1116 | 3906 | 1032 | (*) | LM5 water to M05 water |
| 3906 | 1933 | 3906 | 1935 | (*) | IFL to SAP (opt) |
| 3906 | 1933 | 3906 | 1937 | (*) | IFL to uIFL |
| 3906 | 1935 | 3906 | 1933 | (*) | SAP(opt) to IFL |
| 3906 | 1935 | 3906 | 1937 | (*) | SAP(opt) to uIFL |

| From Machine type | From FC | To Machine type | To FC | | Description |
|---|---|---|---|---|---|
| 3906 | 1937 | 3906 | 1933 | (*) | uIFL to IFL |
| 3906 | 1937 | 3906 | 1935 | (*) | uIFL to SAP (opt) |
| 3906 | 1990 | 3906 | 1898 | (*) | 32GBPreplnd Mem to 32GBCptyIncr |
| 3906 | 1990 | 3906 | 1938 | (*) | 32GBPreplnd Mem to 32GBCptyIncr >1TB |
| 3906 | 1991 | 3906 | 1893 | (*) | 64GBPreplnd Mem to 64GBCptyIncr |
| 3906 | 1991 | 3906 | 1939 | (*) | 64GBPreplnd Mem to 64GBCptyIncr >1TB |

(*) Parts removed as a result of feature conversions become the property of IBM.

## Publications

The following publications are available now in the *Library* section of Resource Link(R):

| Title | Order number |
|---|---|
| IBM 3906 Installation Manual for Physical Planning (IMPP) | GC28-6965 |
| PR/SM™ (TM) Planning Guide | SB10-7169 |
| IOCP User's Guide for ICP | SB10-7172 |
| Planning for Fiber Optic Links | GA23-1408 |

The following publications are shipped with the product and will be available at planned availability in the *Library* section of Resource Link:

| Title | Order number |
|---|---|
| IBM 3906 Installation Manual | GC28-6964 |
| IBM 3906 Service Guide | GC28-6966 |
| Service Guide for TKE Workstations (Version 7.0) | GC28-6980 |
| Systems Safety Notices | G229-9054 |
| IBM Important Notices | G229-9056 |
| IBM 3906 Safety Inspection | GC28-6963 |
| Systems Environmental Notices and User Guide | Z125-5823 |
| Statement of Limited Warranty | GC28-6979 |
| License Agreement for Machine Code | SC28-6872 |
| License Agreement for Machine Code Addendum for Elliptic Curve Cryptography | GC27-2635 |

The following publications will be available at planned availability in the *Library* section of Resource Link:

| Title | Order number |
|---|---|
| IBM 3906 Parts Catalog | GC28-6967 |
| Service Guide for 2461 HMC | GC28-6981 |
| Service Guide for 2461 Support Element | GC28-6982 |
| Service Guide for HMCs and SEs | GC28-6983 |
| Hardware Management Console Security | SC28-6987 |
| SNMP Application Programming Interfaces | SB10-7171 |

| Title | Order number |
|---|---|
| Capacity on Demand User's Guide | SC28-6985 |
| CHPID Mapping Tool User's Guide | GC28-6984 |
| Hardware Management Console Web Services API (V2.14.0) | SC27-2636 |
| IBM Dynamic Partition Manager (DPM) Guide | SB10-7170 |
| Secure Service Container User's Guide | SC28-6978 |
| Integrating the HMC's Broadband RSF into your Enterprise | SC28-6986 |
| SCSI IPL - Machine Loader Messages | SC28-6948 |
| Stand-Alone IOCP User's Guide | SB10-7173 |
| Ensemble Workload Resource Group Management Guide | GC27-2633 |
| Ensemble Planning Guide | GC27-2631 |
| OSA-Express(R) Customer Guide and Reference | SA22-7935 |
| OSA Integrated Console Controller User's Guide | SC27-9003 |
| OSA/SF on the Hardware Management Console | SC14-7580 |
| FICON CTC Reference | SB10-7174 |
| Maintenance Information for Fiber Optic Links | SY27-7696 |

**Resource Link:** Publications for IBM Emperor II can be obtained at the Resource Link website.

Using the instructions on the Resource Link panels, obtain a user ID and password. Resource Link has been designed for easy access and navigation.

**HMC and SE console documentation**

At planned availability, the Hardware Management Console (HMC) and Support Element (SE) console documentation (Version 2.14.0) will be available from IBM Knowledge Center.

IBM Knowledge Center provides you with a single information center where you can access product documentation for IBM systems hardware, operating systems, and server software. Through a consistent framework, you can efficiently find information and personalize your access.

The following Redbooks(R) publications are available now. To order, contact your IBM representative.

| Title | Order number |
|---|---|
| z14 Technical Introduction | SG24-8450-00 |
| z14 Technical Guide | SG24-8451-00 |
| z14 Configuration Setup | SG24-8460-00 |
| IBM z Systems Connectivity Handbook | SG24-5444-17 |
| IBM z Systems Functional Matrix | REDP-5157-02 |

To download these Redbooks publications, go to the IBM zEnterprise(R) System Redbooks website.

For other IBM Redbooks publications, go to the main IBM Redbooks website.

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Details on education offerings related to specific products can be found on the IBM authorized training website.

## Technical information

### Specified operating environment

***Physical specifications***

**Physical specifications -IBM Emperor II Air Cooled Machine**

Dimensions (rounded to the nearest 0.1" or 0.1 cm):

**Systems with all covers**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 73.5 | 63.6 | 79.3 |
| Centimeters | 186.7 | 156.5 | 201.3 |
| Inches (O/H IO cable exit) | 73.5 | 72.7 | 84.8* |
| Centimeters (O/H IO cable exit) | 186.7 | 184.7 | 215.3 |

*Note: The height with overhead I/O cable exit differs from the standard height only with the optional optical cable organizer feature installed.

**Systems with all covers and height reduction**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 73.5 | 61.6 | 70.3 |
| Centimeters | 186.7 | 156.5 | 178.5 |

**Each frame with one side cover and without packaging**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 50.0 | 30.7 | 79.3 |
| Centimeters | 127.0 | 78.0 | 201.3 |

**Each frame on casters with one side cover and with packaging (domestic)**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 57.4 | 32.4 | 79.8 |
| Centimeters | 145.8 | 82.2 | 202.6 |

**Each frame with one side cover and with packaging (ARBO crate)**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 63.4 | 36.5 | 87.6 |
| Centimeters | 161.0 | 92.7 | 222.5 |

***Approximate weight:***

**System with IBF feature**

| | Newbuild Minimum System Model LM1 No I/O drawer | Newbuild Maximum System Model LM5 Max # of I/O drawers |
|---|---|---|
| kg | 1512 | 2714 |
| lb | 3333 | 5983 |
| kg (O/H IO cable exit) | 1566 | 2768 |
| lb (O/H IO cable exit) | 3453 | 6103 |

**System without IBF feature**

| | Newbuild Minimum System Model LM1 No I/O drawer | Newbuild Maximum System Model LM5 Max # of I/O drawers |
|---|---|---|
| kg | 1309 | 2410 |
| lb | 2886 | 5312 |
| kg (O/H IO cable exit) | 1364 | 2464 |
| lb (O/H IO cable exit) | 3006 | 5432 |

To ensure installability and serviceability in non-IBM industry-standard racks, review the installation planning information for any product-specific installation requirements.

The dc power feature has no effect on the machine dimensions and weight.

**Physical specifications -IBM Emperor II Water Cooled Machine**

Dimensions (rounded to the nearest 0.1" or 0.1 cm):

**Systems with all covers**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 77.5 | 61.6 | 79.3 |
| Centimeters | 196.9 | 156.5 | 201.3 |
| Inches (O/H IO cable exit) | 77.5 | 72.7 | 84.8* |
| Centimeters (O/H IO cable exit) | 196.9 | 184.7 | 215.3 |

*Note: The height with overhead I/O cable exit differs from the standard height only with the optional optical cable organizer feature installed.

**Systems with all covers and height reduction**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 77.5 | 61.6 | 70.3 |
| Centimeters | 196.9 | 156.5 | 178.5 |

**Each frame with one side cover and without packaging**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 54.0 | 30.7 | 79.3 |
| Centimeters | 137.2 | 78.0 | 201.3 |

**Each frame on casters with one side cover and with packaging (domestic)**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 61.4 | 32.4 | 79.8 |
| Centimeters | 156.0 | 82.2 | 202.6 |

**Each frame with one side cover and with packaging (ARBO crate)**

| | Depth | Width | Height |
|---|---|---|---|
| Inches | 68. | 36.5 | 87.6 |
| Centimeters | 171.7 | 92.7 | 222.5 |

***Approximate weight:***

**System with IBF feature**

| | Newbuild Minimum System Model LM1 No I/O drawer | Newbuild Maximum System Model LM5 Max # of I/O drawers |
|---|---|---|
| kg | 1546 | 2737 |
| lb | 3408 | 6034 |
| kg (O/H IO cable exit) | 1600 | 2791 |
| lb (O/H IO cable exit) | 3528 | 6154 |

**System without IBF feature**

| | Newbuild Minimum System Model LM1 No I/O drawer | Newbuild Maximum System Model LM5 Max # of I/O drawers |
|---|---|---|
| kg | 1343 | 2433 |
| lb | 2961 | 5363 |
| kg (O/H IO cable exit) | 1398 | 2487 |
| lb (O/H IO cable exit) | 3081 | 5483 |

To ensure installability and serviceability in non-IBM industry-standard racks, review the installation planning information for any product-specific installation requirements.

The dc power feature has no effect on the machine dimensions and weight.

***Operating environment***

**Operating environment -IBM Emperor II Air Cooled Machine**

Environmental class - ASHRAE 3

Temperature: 5° to 40°C (41° to 104°F) for all models up to 900 meters above sea level; maximum ambient reduces 1°C per 300 meters above 900 meters

Relative Humidity: 8% to 85%

Wet Bulb (Caloric Value): 25°C (77°F)

Operating Mode Max Dew Point: 24°C (75.2°F) - Operating Mode

**Electrical power (maximum)**

| Utility | LM1 | LM2 | LM3 | LM4 | LM5 | Power Factor |
|---|---|---|---|---|---|---|
| 200-240 V ac | 10.4 kVA | 19.0 kVA | 23.3 kVA | 28.3 kVA | 29.9 kVA | 0.996 |
| 380-415 V ac | 10.6 kVA | 19.3 kVA | 23.8 kVA | 28.9 kVA | 30.6 kVA | 0,978 |
| 480 V ac | 10.9 kVA | 20.0 kVA | 24.7 kVA | 29.9 kVA | 31.6 kVA | 0.961 |

| Utility | LM1 | LM2 | LM3 | LM4 | LM5 | Power Factor |
|---|---|---|---|---|---|---|
| 400 V dc | 10.1 kW | 18.3 kW | 22.6 kW | 27.4 kW | 29.0 kW | - |

Capacity of Exhaust: 6370 cubic meters / hour (3800 CFM)

Noise level:

- Typical Configuration (Model LM2):
  - Declared A-Weighted Sound Power Level, LWAd(B) = 7.8
  - Declared A-Weighted Sound Pressure Level, LpAm(dB) = 59
- Maximum Configuration (Model LM5):
  - Declared A-Weighted Sound Power Level, LWAd(B) = 8.1
  - Declared A-Weighted Sound Pressure Level, LpAm(dB) = 62

Leakage and Starting Current: 70 mA / 170 A (approximately 100 microseconds)

**Systems**

To ensure installability and serviceability in non-IBM industry-standard racks, review the installation planning information for any product-specific installation requirements.

**Operating environment -IBM Emperor II Water Cooled Machine**

Environmental class - ASHRAE 3

Temperature: 5° to 40°C (41° to 104°F) for all models up to 900 meters above sea level; maximum ambient reduces 1°C per 300 meters above 900 meters

Relative Humidity: 8% to 85%

Wet Bulb (Caloric Value): 25°C (77°F)

Operating Mode Max Dew Point: 24°C (75.2°F) - Operating Mode

**Electrical power (maximum)**

| Utility | LM1 | LM2 | LM3 | LM4 | LM5 | Power Factor |
|---|---|---|---|---|---|---|
| 200-240 V ac | 10.0 kVA | 18.1 kVA | 22.3 kVA | 26.4 kVA | 27.9 kVA | 0.996 |
| 380-415 V ac | 10.2 kVA | 18.6 kVA | 22.9 kVA | 27.1 kVA | 28.6 kVA | 0,978 |
| 480 V ac | 10.5 kVA | 19.3 kVA | 23.7 kVA | 28.1 kVA | 29.6 kVA | 0.958 |
| 400 V dc | 9.7 kW | 17.7 kW | 21.6 kW | 25.6 kW | 27.6 kW | - |

Capacity of Exhaust: 5950 cubic meters / hour (3500 CFM)

Noise level:

- Typical Configuration (Model LM2)
  - Declared A-Weighted Sound Power Level, LWAd(B) = 7.9
  - Declared A-Weighted Sound Pressure Level, LpAm(dB) = 60
- Maximum Configuration (Model LM5)
  - Declared A-Weighted Sound Power Level, LWAd(B) = 8.0
  - Declared A-Weighted Sound Pressure Level, LpAm(dB) = 61

Leakage and Starting Current: 70 mA / 170 A (approximately 100 microseconds)

**Systems**

To ensure installability and serviceability in non-IBM industry-standard racks, review the installation planning information for any product-specific installation requirements.

### *Hardware requirements*

The hardware requirements for the IBM LinuxONE servers, features, and functions are identified. **A new driver level is required.** HMC (V2.14.0) plus MCLs and the Support Element (V2.14.0) are planned to be available on September 13, 2017.

You should review the PSP buckets for minimum Machine Change Levels (MCLs) and software PTF levels before IPLing operating systems.

#### HMC system support

The new functions available on the Hardware Management Console (HMC) version 2.14.0, as described, apply exclusively to IBM Emperor II and z14. However, the HMC version 2.14.0 will also support the systems listed in the table below.

| Family | Machine Type | Firmware Driver | SE Version | Ensemble Node Potential |
|---|---|---|---|---|
| z14 and Emperor II | 3906 | 32 | 2.14.0 | Yes |
| z13™ and Emperor | 2964 | 27 | 2.13.1 | Yes |
| z13s and Rockhopper | 2965 | 27 | 2.13.1 | Yes |
| zBX Node | 2458 Mod 004 | 22 | 2.13.0 | Required |
| zBC12 | 2828 | 15 | 2.12.1 | Yes |
| zEC12 | 2827 | 15 | 2.12.1 | Yes |
| z114 | 2818 | 93 | 2.11.1 | Yes |
| z196 | 2817 | 93 | 2.11.1 | Yes |
| z10™ BC | 2098 | 79 | 2.10.2 | No |
| z10 EC | 2097 | 79 | 2.10.2 | No |

#### Peripheral hardware and device attachments

IBM devices previously attached to IBM System z196, z114, zEC12, zBC12, z13, Emperor, z13s, Rockhopper, and z14 servers are supported for attachment to IBM Emperor II channels, unless otherwise noted. The subject I/O devices must meet the FICON and Fibre Channel Protocol (FCP) architectures to be supported. I/O devices that meet OEMI architecture requirements are supported only using an external converter. Prerequisite Engineering Change Levels may be required. For further detail, contact IBM service personnel.

While the IBM Emperor II supports devices as described above, IBM does not commit to provide support or service for an IBM device that has reached its End of Service effective date as announced by IBM.

Note: IBM cannot confirm the accuracy of performance, compatibility, or any other claims related to non-IBM products. Questions regarding the capabilities of non-IBM products should be addressed to the suppliers of those products.

Information on switches and directors qualified for IBM Z FICON and FCP channels can be found in the *Library* section of Resource Link .

### *Software requirements*

**IBM Emperor II requires at a minimum:**

- z/VM V6.4 with PTFs (compatibility including Crypto Express6S and OSA-Express6S support, z/Architecture® IPL).

- z/VM V6.3 with PTFs (compatibility including Crypto Express6S and OSA-Express6S support, z/Architecture IPL).
- Linux on z Systems™-IBM plans to support running the following Linux on z Systems distributions on IBM Emperor II:
  - SUSE SLES 12 SP2 with service and SUSE SLES 11 SP4 with service.
  - Red Hat RHEL 7.3 with service and Red Hat RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**The following software requirements are listed for features and capabilities supported on IBM Emperor II:**

**FICON Express16S+ (CHPID type FC)** when utilizing FICON or Channel-To-Channel (CTC), requires at a minimum:

- z/VM V6.4.
- z/VM V6.3.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**FICON Express16S+ (CHPID type FC)** for support of zHPF single-track operations requires at a minimum:

- z/VM V6.4.
- z/VM V6.3 for guest exploitation.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**FICON Express16S+ (CHPID type FC)** for support of zHPF multitrack operations requires at a minimum:

- z/VM V6.4.

- z/VM V6.3 for guest exploitation.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**FICON Express16S+ (CHPID type FCP)** for support of SCSI devices requires at a minimum:

- z/VM V6.4.
- z/VM V6.3.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**FICON Express16S+ (CHPID type FCP) support of hardware data router** requires at a minimum:

- z/VM V6.4 for guest exploitation.
- z/VM V6.3 for guest exploitation.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**T10-DIF support** by the FICON Express16S+ features when defined as CHPID type FCP requires at a minimum:

- z/VM V6.4 for guest exploitation.
- z/VM V6.3 for guest exploitation.
- Linux on z Systems:
  - SLES 12 SP2 with service (DIF and DIX) and SLES 11 SP4 with service (DIF and DIX).

  - RHEL 7.3 with service (DIF and DIX) and RHEL 6.9 with service (DIF only).
  - Ubuntu 16.04 LTS (or higher) with service (DIF and DIX).
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**OSA-Express6S GbE LX (#0422) and GbE SX (#0423)** require at a minimum:

CHPID type OSD:

- z/VM V6.4 with PTFs.
- z/VM V6.3 with PTFs.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

CHPID type OSD without maximum port exploitation (one port on the PCIe adapter is available for use):

- z/VM V6.4 with PTFs.
- z/VM V6.3 with PTFs.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**OSA-Express6S 10 GbE LR (#0424) and 10 GbE SR (#0425)** require at a minimum:

CHPID type OSD:

- z/VM V6.4 with PTFs.
- z/VM V6.3 with PTFs.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.

  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.

- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

CHPID type OSX for access control to the intraensemble data network (IEDN) from IBM Emperor II to Unified Resource Manager functions:

- z/VM V6.4 to define, modify, and delete OSX CHPID types when z/VM is the controlling LPAR for dynamic I/O.
- z/VM V6.3 to define, modify, and delete OSX CHPID types when z/VM is the controlling LPAR for dynamic I/O.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**OSA-Express6S 1000BASE-T Ethernet (#0426)** requires at a minimum:

CHPID type OSD with exploitation of two ports per CHPID:

- z/VM V6.4 with PTFs.
- z/VM V6.3 with PTFs.

CHPID type OSD without maximum port exploitation (one port on the PCIe adapter is available for use):

- z/VM V6.4 with PTFs.
- z/VM V6.3 with PTFs.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.

CHPID type OSM for intranode management network (INMN) :

- z/VM V6.4 to define, modify, and delete CHPID type OSM when z/VM is the controlling LPAR for dynamic I/O.
- z/VM V6.3 to define, modify, and delete CHPID type OSM when z/VM is the controlling LPAR for dynamic I/O.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.

  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.

- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**Crypto Express6S (#0893) Toleration,** which treats Crypto Express6S cryptographic coprocessors and accelerators as Crypto Express5 coprocessors and accelerators, requires at a minimum:

- z/VM V6.4 with PTFs for guest exploitation and exploitation within the z/VM TLS/SSL server.
- z/VM V6.3 with PTFs for guest exploitation.
- Linux on z Systems: IBM is working with its Linux distribution partners to provide support via maintenance or future distribution releases for:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**Crypto Express6S (#0893) support of greater than 16 Domains** requires at a minimum:

- z/VM V6.4 with PTFs for guest exploitation and exploitation within the z/VM TLS/SSL server.
- z/VM V6.3 with PTFs for guest exploitation.
- Linux on z Systems: IBM is working with its Linux distribution partners to provide support via maintenance or future distribution releases for:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**Crypto Express6S (#0893) Exploitation** requires at a minimum:

- z/VM V6.4 with PTFs for guest exploitation.
- z/VM V6.3 with PTFs for guest exploitation.
- Linux on z Systems: IBM is working with its Linux distribution partners to provide support future distribution releases.

**10GbE RoCE Express2 (#0412) for Shared Memory Communications - Remote Direct Memory Access (SMC-R)** requires at a minimum:

- z/VM V6.4 with PTFs for guest exploitation.
- z/VM V6.3 with PTFs for guest exploitation.
- Linux on z Systems: IBM is working with its Linux distribution partners to provide support via maintenance or future distribution releases for:
  - SLES 12 SP2.
  - RHEL 7.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**10GbE RoCE Express2 (#0412) for Ethernet communications (which does not require a peer OSA) including Single Root I/O Virtualization (SR-IOV)** requires at a minimum:

- z/VM V6.4 with PTFs for guest exploitation.
- z/VM V6.3 with PTFs for guest exploitation.
- Linux on z Systems: Currently limited to experimental support in:
  - SLES 12 SP2.
  - RHEL 7.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**zEDC Express (#0420)** requires at a minimum:

- z/VM V6.4 for guest exploitation.
- z/VM V6.3 for guest exploitation.
- Linux on z Systems:
  - SLES 12 SP2 with service.
  - RHEL 7.3 with sevice.
  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.
- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**Transactional memory** requires at a minimum:

- z/VM V6.4 for guest exploitation.
- Linux on z Systems:
  - SLES 12 SP2 with service and SLES 11 SP4 with service.
  - RHEL 7.3 with service and RHEL 6.9 with service.

  - Ubuntu 16.04 LTS (or higher) with service.
  - IBM will be working to support the KVM hypervisor which is offered with the following Linux distributions: SLES 12 SP2 with service, and Ubuntu 16.04 LTS (or higher) with service.

    Note: For minimum required and recommended distribution levels refer to the IBM Z website.

- KVM for IBM Z 1.1.2 with latest Fixpack (toleration mode, until End of Service in March 2018).

**2 GB Large Pages** requires at a minimum:

- Linux on z Systems: IBM is working with its Linux distribution partners to provide support via future distribution releases.

**Guarded Storage** requires at a minumum:

- z/VM V6.4 with PTFs for guest exploitation (December 15, 2017 availability).
- Linux on z Systems: IBM is working with its Linux distribution partners to provide support via future distribution releases.

**Instruction Execution Protection Facility** requires at a minumum:

- z/VM V6.4 with PTFs for guest exploitation (December 15, 2017 availability).
- Linux on z Systems: IBM is working with its Linux distribution partners to provide support via future distribution releases.

## Planning information

### *Customer responsibilities*

Information on customer responsibilities for site preparation can be found in the Library section of Resource Link.

### *Installability*

The average installation time for an IBM Emperor II is approximately 22 installer hours. This does not include planning hours. This assumes a full System Assurance Product Review, and implementation of the cable services have been performed. See your IBM representative for details on these services.

## Security, auditability, and control

The Emperor II uses the security and auditability features and functions of host hardware, host software, and application software.

The customer is responsible for evaluation, selection, and implementation of security features, administrative procedures, and appropriate controls in application systems and communications facilities.

### Global Technology Services

Contact your IBM representative for the list of selected services available in your country, either as standard or customized offerings, for the efficient installation, implementation, and/or integration of this product.

## Terms and conditions

### Products - terms and conditions

***Warranty period***

One year.

The following features are available on IBM LinuxONE machines (3906: LM1, LM2, LM3, LM4, LM5) but are not supported by IBM and are not warranted (that is, they are provided by IBM as is):

- 0025 Ensemble membership

To obtain copies of the IBM Statement of Limited Warranty, contact your reseller or IBM. An IBM part or feature installed during the initial installation of an IBM machine is subject to the full warranty period specified by IBM. An IBM part or feature that replaces a previously installed part or feature assumes the remainder of the warranty period for the replaced part or feature. An IBM part or feature added to a machine without replacing a previously installed part or feature is subject to a full warranty. Unless specified otherwise, the warranty period, type of warranty service, and service level of a part or feature are the same as those for the machine in which it is installed.

***Warranty service***

The specified level of maintenance service may not be available in all worldwide locations. Additional charges may apply outside IBM's normal service area. Contact your local IBM representative or your reseller for country- and location-specific information. IBM will repair the failing machine at your location and verify its operation. You must provide a suitable working area to allow disassembly and reassembly of the IBM machine. The area must be clean, well lit, and suitable for the purpose. The following service is available as warranty for your machine type.

- 24 hours per day, 7 days a week, same day response

***Warranty service upgrades***

The specified level of maintenance service may not be available in all worldwide locations. Additional charges may apply outside IBM's normal service area. Contact your local IBM representative or your reseller for country- and location-specific information.

IBM On-site Service: IBM will repair the failing machine at your location and verify its operation. You must provide a suitable working area to allow disassembly and reassembly of the IBM machine. The area must be clean, well lit, and suitable for the purpose.

The following service is provided.

- 24 hours per day, 7 days a week, same day response.

***Usage plan machine***

No

### *IBM hourly service rate classification*

Three

When a type of service involves the exchange of a machine part, the replacement may not be new, but will be in good working order.

### *Maintenance service offerings*

**Committed Services (CS):** For service options with a committed level of service or any other special service option, contact your IBM representative. See the following European documents:

- Announcement Letter ZS03-0150 for IBM Customer Agreement (ICA)
- Announcement Letter ZS04-0135 for Enterprise Agreement Contract
- Announcement Letter ZS98-0118 for ServiceSuite Contract

## General terms and conditions

### *Field-installable features*

Yes

### *Model conversions*

Yes

### *Machine installation*

Installation is performed by IBM. IBM will install the machine in accordance with the IBM installation procedures for the machine.

Contact the local IBM office.

### *Graduated program license charges apply*

No

### *Licensed Internal Code*

IBM Licensed Internal Code (LIC) is licensed for use by a customer on a specific machine, designated by serial number, under the terms and conditions of the IBM License Agreement for Machine Code, to enable a specific machine to function in accordance with its specifications, and only for the capacity authorized by IBM and acquired by the customer. You can obtain the agreement by contacting your IBM representative or going to the License Agreement website.

Specific Machine Type Model:

- 3906-LM1
- 3906-LM2
- 3906-LM3
- 3906-LM4
- 3906-LM5

### *Licensed Machine Code*

Not applicable

### *Other Installed Licensed Code*

None

## Prices

For all local charges, contact your IBM representative.

### IBM Global Financing

IBM Global Financing provides purchasing power to help create the competitive advantage and financial stability customers need to save, re-invest, and innovate their IT infrastructure. We offer credit-qualified customers a range of customizable leasing options and payment plans, ready to be tailored to meet specific project needs. Financing solutions from IBM Global Financing can help you stretch your budget and affordably acquire new technology solutions. Our offerings include financing for IT acquisition, including hardware, software, and on- and off-premises services from both IBM and other manufacturers or vendors. Beyond the initial acquisition, our end-to-end approach to IT management can also help keep technology current, reduce costs, minimize risk, and preserve your ability to make flexible IT infrastructure decisions throughout the entire technology lifecycle. Contact your local IBM Global Financing organization or go to the IBM Financing website for more information.

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## Announcement countries

All European, Middle Eastern, and African countries, except Islamic Republic of Iran, Sudan, and Syrian Arab Republic.

### *Trademarks*



### *Terms of use*

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Terms of use

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IBM Directory of worldwide contacts