IBM z16™ puts innovation to work while unlocking the potential of your hybrid cloud transformation

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At a glance

Introducing the innovative IBM(R) z16 multiframe system

The IBM Z(R) platform is recognized for its security, resiliency, performance, and scale--relied upon by businesses around the globe for mission-critical workloads and as an essential element of their hybrid cloud infrastructure.[1] IBM z16, the first IBM Z system built with the IBM Telum Processor, extends the platform's capabilities and adds new value with innovative technologies that businesses require as they digitally transform their enterprises. IBM z16 is designed to help businesses:

- Create new value in every customer interaction and optimize decision-making with a new on-chip AI accelerator designed to deliver the speed and scale required to infuse AI inferencing into enterprise workloads while maintaining service level agreements (SLAs)
- Act now to protect today's data against current and future threats with the industry's first quantum-safe system,[2] new quantum-safe cryptography application programming interfaces (APIs), and crypto discovery tools.
- Enhance resiliency with new flexible capacity to dynamically shift system resources across locations to proactively avoid disruptions
- Modernize and integrate applications and data in a hybrid cloud environment with a consistent hybrid cloud experience and flexible deployment options to innovate with increased speed and agility
- Reduce cost and keep up with new and changing regulations with a new compliance solution that helps simplify and streamline compliance tasks

[1] ITIC 2021 Global Server Hardware Server OS Reliability Report, June/July 2021.

[2] IBM z16 with the Crypto Express8S card offers quantum-safe APIs that provide access to quantum-safe algorithms, which have been selected as finalists during the PQC standardization process conducted by NIST Information Technology Laboratory. Quantum-safe cryptography refers to efforts to identify algorithms that are resistant to attacks by both classical and quantum computers, to keep information assets secure even after a large-scale quantum computer has been built. Source: ETSI Quantum-Safe Cryptography (QSC). These algorithms are used to help ensure the integrity of a number of the firmware and boot processes. IBM z16 is the industry-first system protected by quantum-safe technology across multiple layers of firmware.

Overview

Businesses across the world in every industry are investing in digital transformation with the rate and pace increasing over the past several years.[3,4] IBM z16 is built

for hybrid cloud and can help expedite your transformation with new on-chip AI acceleration to enable decision velocity, quantum-safe technologies to designed to help protect your business now and into the future, a flexible infrastructure to meet the resiliency and compliance demands of a constantly changing environment, and with capabilities to accelerate modernization and delivery of new services.

Predict and automate with accelerated AI

An approach where data gravity and transaction gravity intersect, that co-locates data, transactional systems, and AI inferencing, can deliver insights at speed and scale to enable decision velocity. Decision velocity means delivering insights faster to make decisions to help identify new business opportunities, improve customer experience, and reduce operational risk.

- IBM z16's new on-chip Integrated Accelerator for AI is designed for high-speed, real-time inferencing at scale. The on-chip AI acceleration is designed to add more than 6 TFLOPS of processing power shared by all cores on the chip. This centralized AI design is intended to provide extremely high performance and consistent low-latency inferencing for processing a mix of transactional and AI workloads at speed and scale. Now complex neural network inferencing that leverages real-time data can be executed and deliver insights within high-throughput enterprise workloads in real time while still meeting stringent SLAs.
- A robust ecosystem of frameworks and open source tools combined with the new IBM Deep Learning Compiler, which generates inferencing programs that are highly optimized for the IBM Z architecture and the Integrated Accelerator for AI, help enable rapid development and deployment of deep learning and machine learning models on IBM Z to accelerate time to market.

Secure with a cyber resilient system

Along with the opportunity created by quantum computing comes the threat to today's public key cryptography. Businesses must start now to prepare for the time when a quantum computer can break today's cryptography. In fact, today's data is at risk for future exposure through "harvest now, decrypt later" attacks.

- IBM z16 is the industry-first quantum-safe system, [2] protected by quantum-safe technology across multiple layers of firmware. Quantum-safe secure boot technology helps protect IBM z16 firmware from quantum attacks through a built-in dual signature scheme with no configuration changes required for enablement.[2]
- With the new Crypto Express8S (CEX8S), IBM z16 helps deliver quantum-safe APIs that will position businesses to begin using quantum-safe cryptography along with classical cryptography as they begin modernizing existing applications and building new applications.
- Discovering where and what kind of cryptography is being used is a key first step along the journey to quantum-safety. IBM z16 provides new instrumentation that can be used to track cryptographic instruction execution in the CP Assist for Cryptographic Functions (CPACF). Additionally, the IBM Application Discovery and Delivery Intelligence (ADDI) software product has been enhanced with new crypto discovery capabilities.

To move their enterprises forward in a world that is constantly changing, businesses require an infrastructure that is flexible, secure, and resilient. The risk and potential disruption from extreme weather events, cyberattacks, and more continues to increase. An ever-changing and complex regulatory environment is also driving up the cost to maintain and keep up with regulations.

- IBM z16 enhancements in resiliency include a new capability called IBM Z Flexible Capacity for Cyber Resiliency. With Flexible Capacity for Cyber Resiliency, you can remotely shift capacity and production workloads between IBM z16 systems at different sites on demand and stay at the alternate site for up to one year. This capability can help demonstrate compliance with regulations that require organizations to be able to dynamically shift production to an alternate site and remain there for an extended period of time. This capability is also

designed to help you proactively avoid disruptions from unplanned events. For example, it enables you to move production workload to avoid disruptions from an impending hurricane, flood, or wildfire, as well from planned scenarios such as site facility maintenance.

- New System Recovery Boost enhancements are also available with IBM z16. The enhancements can provide boosted processor capacity and parallelism for specific events. Client-selected middleware starts and restarts may be boosted to expedite recovery for middleware regions and restore steady-state operations as soon as possible. SVC dump processing and HyperSwap(R) configuration load and reload may be boosted to minimize the impact to running workloads.

- Parallel Sysplex(R) enhancements include improved Integrated Coupling Adapter Short Reach (ICA SR) performance and Coupling Facility (CF) image scalability, technology and protocol upgrades for coupling links, simplified Dynamic CF Dispatching (DYNDISP) support, and resiliency enhancements for CF cache and lock structures.

- The new IBM Z Security and Compliance Center software product is designed to help simplify and streamline compliance tasks. This solution will help provide a centralized, interactive dashboard for a consolidated view of compliance posture and system-generated evidence in near real time. You can now check the regulatory posture of your systems on demand and more easily identify drift so that it can be remedied quickly.

Modernize for hybrid cloud

IBM z16 delivers new technology innovation in AI, security, and resiliency on a flexible infrastructure designed for mission-critical workloads in a hybrid cloud environment. IBM z16 continues to deliver new and improved cloud capabilities on the platform. IBM z16 provides the foundation for application modernization and hybrid cloud velocity by delivering leading hybrid cloud infrastructure to support the optimization of existing mission-critical applications and data. IBM z16 and the accompanying IBM Z and cloud software, which is developed to support a cloud-native experience, delivers a broad set of open and industry-standard tools, including an agile DevOps methodology to accelerate modernization. These capabilities deliver speed to market and agility for both development and operational teams as IBM z16 integrates as a critical component of hybrid cloud.

Businesses can accelerate modernization and delivery of new services by leveraging these key software offerings along with IBM z16:

- IBM Z and Cloud Modernization Stack to help empower developers to modernize and integrate z/OS(R) applications with services across the hybrid cloud. This solution provides a flexible and integrated platform to support z/OS-based cloud-native development, application, and data modernization and infrastructure automation.

- Red Hat(R) OpenShift(R) and IBM Cloud(R) Paks running on IBM z16 infrastructure provide the combination of infrastructure, hybrid cloud container platform, and middleware to modernize existing applications and develop cloud-native applications that integrate, extend, and supply data and workloads from IBM z16 across the hybrid cloud with Red Hat OpenShift.

[2] IBM z16 with the Crypto Express8S card offers quantum-safe APIs that provide access to quantum-safe algorithms, which have been selected as finalists during the PQC standardization process conducted by NIST Information Technology Laboratory. Quantum-safe cryptography refers to efforts to identify algorithms that are resistant to attacks by both classical and quantum computers, to keep information assets secure even after a large-scale quantum computer has been built. Source: ETSI Quantum-Safe Cryptography (QSC). These algorithms are used to help ensure the integrity of a number of the firmware and boot processes. IBM z16 is the industry-first system protected by quantum-safe technology across multiple layers of firmware.

[3] "COVID-19 and the future of business,"IBM Institute for Business Value, September 2020, https://www.ibm.com/thought-leadership/institute-business-value/covid-19.

4 "Forrester Analytics Business Technographics Infrastructure Survey," Forrester.com, 2020, https://www.forrester.com/Business+Technographics+Infrastructure+Survey+2020/-/E-sus6031?objectid=SUS6031.

Key requirements

See the Hardware requirements and Software requirements sections.

Planned availability date

May 31, 2022

New-build systems:
* IBM z16™ Model A01
* Features and functions for IBM z16

Upgrades from IBM z14^(R) and IBM z15™:

Upgrades from IBM z14[R] and IBM z15[TM]:
* IBM z14 radiator-cooled upgrades to IBM z16 Model A01
* IBM z14 water-cooled upgrades to IBM z16 Model A01
* IBM z15 radiator-cooled upgrades to IBM z16 Model A01
* IBM z15 water-cooled upgrades to IBM z16 Model A01

MES orders for IBM z16 that include the following features:
* Field-installed features and conversions on IBM z16 that are delivered solely through a modification to the machine's Licensed Internal Code (LIC)
* HMA IBM Z HW Mgmt Appliance (#0129) on IBM z16
* TKE Rack Mount (#0057) on IBM z16
* TKE Tower (#0058) on IBM z16
* TKE Rack KMM (#0156) on IBM z16
* TKE Table Top KMM (#0157) on IBM z16
* TKE Tower (#0144) on IBM z16
* TKE Rack (#0145) on IBM z16
* TKE Rack (#0233) on IBM z16
* TKE Tower (#0234) on IBM z16
* TKE 10.0 LIC (#0882) on IBM z16
* TKE addl smart cards (#0900) on IBM z16
* TKE smart card reader (#0891) on IBM z16

July 1, 2022 - orders cannot be placed until July 1, 2022
* TKE Rack Mount (#0057) on IBM z15
* TKE Tower (#0058) on IBM z15
* TKE Rack KMM (#0156) on IBM z15
* TKE Table Top KMM (#0157) on IBM z15
* TKE Tower (#0144) on IBM z15
* TKE Rack (#0145) on IBM z15
* TKE Rack (#0233) on IBM z15
* TKE Tower (#0234) on IBM z15
* TKE 10.0 LIC (#0882) on IBM z15

September 13, 2022 - orders cannot be placed until   September 13, 2022
* Bulk Power^(R) Assembly (BPA, #0648)

September 30, 2022

    * All remaining MES orders for IBM z16 Model A01

Availability within a country is subject to local legal requirements.

Description

The newest member of the IBM Z family, IBM z16[tm] will fit seamlessly in your data center with its industry-standard sizing, power, and networking. The system features the IBM Telum Processor with its dedicated on-chip accelerator for AI inference to enable real-time AI embedded directly in transactional workloads, as well as improvements for performance, security, and availability. The system is designed to enable you to flexibly scale up to four frames in a single system and integrate additional hardware appliances into an industry-standard form factor. Clients can easily consolidate down to fewer frames or scale-up for growth.

The new IBM z16 delivers innovation and benefits in several key areas

Core system

- IBM z16 has a maximum of 200 client-configurable cores, which is an increase of 10 over IBM z15. IBM z16 single processor capacity is designed to enable equal n-way at common client configurations, approximately 11% greater than on IBM z15 with some variation based on workload and configuration.[5]
- The largest IBM z16 is expected to provide approximately 17% more total system capacity as compared to the largest IBM z15 with some variation based on workload and configuration. Within each single drawer, IBM z16 provides 25% greater capacity than IBM z15, for standard models and 40% greater capacity on the max config model, enabling efficient scaling of partitions.[5]
- IBM z16 has a completely redesigned cache subsystem, consisting of semiprivate 32 MB Level-2 (L2) caches per core that are working in concert to provide up to 256 MB virtual Level-3 (L3) cache per chip and up to 2 GB virtual Level-4 (L4) cache per drawer. The result is that virtual L3 and L4 caches provide 1.5 times the cache capacity per core compared to IBM z15.
- IBM z16 supports up to 10 TB of main memory per drawer and 40 TB per system based on a newly designed memory buffer chip that provides up to DDR4-3200 memory speed, depending on memory size, delivering 50% more memory bandwidth per drawer than IBM z15. This is designed to improve overall workload performance, particularly for data-intensive analytics and AI applications. The new memory interface uses transparent memory encryption technology to protect all data leaving the processor chips before it's stored in the memory DIMMs.
- IBM z16 has 20 new instructions to help improve COBOL and AI applications, including instructions to leverage a new AI accelerator.

Security and cryptography

- IBM z16 quantum-safe technology is designed to enable you to act now to help future proof your business. IBM z16 leverages quantum-safe technologies to help protect your business-critical infrastructure and data from potential quantum attacks.[2]
- IBM z16 secure boot technology protects system firmware integrity by using quantum-safe and classical digital signatures to perform a hardware-protected verification of the IML firmware components.[2]
- The new Crypto Express8S is designed to meet the Federal Information Processing Standards (FIPS) 140-3 at Level 4 for cryptographic modules.
- IBM's Common Cryptographic Architecture release 8.0 (CCA 8.0) is designed to be certified to meet the hardware security module (HSM) requirements from the Payment Card Industry Security Standards Council (PCI-SSC).
- The CEX8S with Enterprise PKCS #11 (EP11) firmware offers enhancements that are designed to increase performance significantly in the areas of random number generation as well as message digest calculation.

- The Trusted Key Entry (TKE) 10.0 level of the licensed internal code (LIC) enables you to manage the CEX8S using the TKE.

Networking and I/O

- OSA-Express7S 1.2 GbE, 10 GbE, 1000Base-T, and 25 GbE.
- RoCE Express3 10 GbE and 25 GbE LR and SR, in support of the SMC-R and SMC-Rv2 protocols, as well as use by Linux[R] on IBM Z for all networking communications protocols.
- FICON[R] Express32S (#0461 and #0462) to help absorb large application and transaction spikes driven by large unpredictable AI and hybrid cloud workloads. Also a key component of the IBM Fibre Channel Endpoint Security solution.
- Coupling Express2 LR, which provides technology upgrades and currency, along with improved link traffic management protocols compared to previous generations of long-reach coupling links.
- A new level of coupling facility support, CFLEVEL 25, which provides a variety of enhancements for improved coupling facility performance, scalability, and resiliency. For details, see the following sections in this document:
  - IBM z16 Coupling and Parallel Sysplex enhancements and CFLEVEL 25 support
  - CF cache and lock structure resiliency improvements
  - CF cache structure object residency time monitoring and metrics
- Crypto Express8S (CEX8S), which is available in 1 HSM (#0909) and 2 HSM (#0908) versions.

Systems management and infrastructure

- IBM Hardware Management Console (HMC) 2.16.0 offers simplification updates designed to improve workspace and manage system time.
- The IBM Z Hardware Management Appliance (#0129) provides redundant HMCs and Support Elements (SEs) that run on redundant physical servers inside the Central Processor Complex (CPC) frame. The HMCs and SEs in an HMA have the same physical network redundancy as the standalone HMCs and SEs.
- Dynamic Partition manager (DPM) continues to enhance its set of capabilities. With IBM z16, DPM is designed to provide a seamless experience to configure low latency SMC-Dv2 network links between two or more logical partitions running on the same physical server, all through a single point of control. This enables system administrators and system programmers to accomplish time-consuming and potentially error-prone operations with an intuitive and guided user experience.

Performance

IBM's Large Systems Performance Reference (LSPR) method is designed to provide comprehensive z/Architecture[R] processor capacity ratios for different configurations of central processors (CPs) across a wide variety of system control programs and workload environments.

For IBM z16, the z/Architecture processor capacity indicator is defined with a 4XX, 5XX, 6XX, or 7XX notation, where XX is the number of installed CPs.

In addition to the general information provided for z/OS, the LSPR also contains performance relationships for z/VM[R] and Linux operating environments.

Single processor capacity of IBM z16 (3931) for equal n-way at common client configurations is approximately 11% greater than on IBM z15 (8561) with some variation based on workload and configuration.[5] The largest IBM z16 (3931-7K0) is expected to provide approximately 17% more capacity than the largest IBM z15 (8561-7J0) with some variation based on workload and configuration.[5]

The IFL and zIIP processors on IBM z16 also provide an optional IBM z16 multithreading technology capability; with the multithreading function enabled, the

performance capacity of an IFL or zIIP is expected to typically be up to 25% higher than without the multithreading function enabled.[1]

The LSPR contains the Internal Throughput Rate (ITTR) ratios for IBM z16 and the previous-generation IBM Z processor families based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that a user may experience will vary depending on considerations such as the level of multiprogramming in the user's job stream, the I/O configuration, the workload processed, and the LPAR configuration. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance estimates stated. For more detailed performance information, consult the LSPR available at the Resource Link[(R)] website.

IBM Z Integrated Accelerator for AI

IBM Z Integrated Accelerator for AI is designed to provide machine learning acceleration with high throughput and low latency. IBM Telum has a centralized chip-based AI accelerator designed to support real time computing at scale and provides a high data bandwidth interface to the cache and memory hierarchy optimized to deliver high inference throughput. This centralized AI design is intended to provide extremely high performance and consistent low latency inferencing for processing transactional workloads leveraging AI at speed and scale. IBM Z Integrated Accelerator for AI is designed to meet demanding response time requirements of real-time workloads, for instance in the banking and healthcare industry. For example, clients can benefit from the AI acceleration enabled by the IBM Z Integrated Accelerator for AI to detect fraud in real time to reduce revenue loss due to fraud.

Implemented as an architected memory-to-memory instruction accelerating the most heavily used high-level AI functions like matrix multiplication or convolution, the IBM Z Integrated Accelerator for AI has direct access to the application data resulting in reduced data movement and improved performance. The IBM Z Integrated Accelerator for AI is targeted to accelerate deep learning AI models, like recurrent neural networks (RNN) and convolutional neural networks (CNN), at a higher throughput rate and low latency. Enterprises that use IBM CICS[(R)] Transaction Server for z/OS (CICS TS), IBM Information Management System (IMS) Transaction Manager, IBM z/TPF, or IBM WebSphere[(R)] Application Server for z/OS can exploit the IBM Z Integrated Accelerator for AI when using deep learning AI models, by using one of the existing options for invoking AI models in their applications.

There is an emerging industry need for organizations to work with existing infrastructure. Data scientists want to simplify operationalizing their existing AI investments when integrating them with IBM Z. IBM z16 supports popular AI frameworks and tooling such as TensorFlow, Spark, SnapML, Pytorch, Open Neural Network Exchange (ONNX), and the IBM Deep Learning Compiler (DLC), with optimizations that leverage the IBM Z Architecture including the AI Accelerator. With technologies and tooling such as ONNX and Watson Machine Learning for z/OS, data scientists can develop and train their models with familiar tools and common platforms such as x86, Power, IBM Z and LinuxONE. They can then port their data science assets and deploy them on IBM Z seamlessly to deliver more consistent, repeatable production qualities of service. By allowing clients to bring their own models for deployment on IBM Z, organizations can leverage their existing investments in people, process and infrastructure. By deploying AI on IBM Z, you can benefit from the quality of service such as scale, resiliency, and security to get the most out of your infrastructure investment.

IBM Deep Learning Compiler (DLC) enables deep learning models to be deployed on IBM Z, exploiting the IBM Integrated Accelerator for AI. The DLC is included as part of Watson Machine Learning for z/OS with enhanced capabilities and model management. It is also available in a community version.

IBM Z Deep Neural Network library (zDNN) is a software library that provides high-level C APIs, which enable simplified exploitation of the IBM Z Integrated Accelerator for AI by AI frameworks and libraries. Additionally, it has been made available through open source channels. The IBM zDNN library provides APIs for

the deep learning and machine learning primitives that are accelerated by the IBM Z Integrated Accelerator for AI. AI framework developers, AI compiler developers, as well as runtime providers, can leverage the zDNN accelerated primitive APIs to drive the exploitation of the IBM Z Integrated Accelerator for AI through the new Neural Network Processor Assist (NNPA) facility instruction. The zDNN library enables high-level language exploitation of the optimized NNPA implementation for matrix multiplication, convolution, activation functions, and many other standard DNN primitives. The zDNN library is available with z/OS and for Linux on IBM Z distributions.

IBM Db2(R) 13 for z/OS offers new capabilities to help increase business resiliency, reduce downtime, and enhance application performance and stability--ultimately reducing cost. It provides an innovative database-integrated approach to developing and deploying AI insights within applications. The new IBM Db2 SQL Data Insights feature can readily integrate AI within any application to identify and monetize hidden insights within Db2 for z/OS data.

IBM Db2 AI for z/OS 1.5 helps improve database operational performance, security, resource consumption, and connectivity to deliver agility, automation, and self-management through infused AI.

IBM Z Flexible Capacity for Cyber Resiliency

Flexible Capacity for Cyber Resiliency is a new Capacity on Demand (CoD) offering available on IBM z16 machines that allows processing capacity flexibility between an organization's primary site and alternate data centers.

Flexible Capacity for Cyber Resiliency is designed to provide increased flexibility and control to organizations that want to shift production capacity between participating IBM z16 servers at different sites. The capacity of any engine type can be shifted up to 12 times a year and stay at the target machine for up to 12 months after the flexible capacity record activation on the target machine. Capacity shifts can be done under full client control without IBM intervention and can be fully automated using IBM GDPS(R) automation tools. Flexible Capacity for Cyber Resiliency can be combined with other IBM On-Demand offerings.

Flexible Capacity for Cyber Resiliency supports a broad set of use case scenarios:

- *Proactive outage avoidance*

    Flexible Capacity for Cyber Resiliency can help protect critical business services from disruption from unplanned events. The ability to shift production capacity and workloads to an alternate site at any time and remain there for an extended period of time can help businesses proactively avoid outages from events such as extreme weather events, rolling power outages, and more.

- *Compliance*

    Regulators around the globe are introducing more stringent policies in relation to business continuity and disaster recovery (DR), requiring more comprehensive and extended testing. Many clients have been mandated to switch over full production workloads and operate for a period of 30 days up to 6 months out of their secondary data centers. Flexible Capacity for Cyber Resiliency is designed to help to improve an organization's compliance posture to meet existing and evolving regulatory requirements that require rapid restoration of production workloads.

- *DR and DR testing*

    Flexible Capacity for Cyber Resiliency enables you to transfer the capacity needed at the DR site to continue running production workloads. You can automate and test recovery procedures for unplanned outages, including cyberattacks, to provide near-continuous availability and DR.

- *Facility maintenance*

    You can run production workloads from an alternate site with all the capacity needed to perform maintenance at the source site.

To accommodate the capacity shift, a new temporary capacity record called a Flexible Capacity Record is introduced. The record will be installed on both the IBM z16 source and the IBM z16 target systems.

The source and target IBM z16 systems must be installed in different locations using z/OS V2.2 or above. The capacity is shifted without automation and then optionally, GDPS 4.4 is enabled to provide automation. Necessary resiliency technology must be enabled, such as system-managed CF structure duplexing, sysplex failure management, and Capacity Provisioning Manager. Other configurations may provide different availability characteristics. Clients may optionally use other third-party tools for automation purposes.

Ordering

Flexible Capacity for Cyber Resiliency can be ordered through e-config. The offering requires an order placed against each serial number (SN) involved in capacity transfer, or one record per SN.

- New feature codes (FCs) are introduced: Flexible Capacity Authorization (#9933), Flexible Capacity Record (#0376), and billing feature codes (#0317 through #0322, and #0378 through #0386).
- Flexible Capacity Records are configured using the ODC tab in e-config.
- The configuration panel displays quantity boxes for IFLs, ICFs, zIIPs, term years (one through five), and a selection list of supported CP capacity software model targets.
- All parameter fields will be replenishable through an MES to the record.
- The record is capable of being delivered electronically if the entire MES qualifies.
- Record validation can only be performed for SNs when placing an order, not across SNs participating in capacity transfer.
- Flexible Capacity Records will carry forward to future machine type upgrades into IBM z16.

e-config will calculate and auto-add billing FCs for any delta capacity configured to support the capacity transfer. Flexible Capacity for Cyber Resiliency is a prepaid offering, available as a yearly subscription or perpetual license.

Installation and setup

The new Flexible Capacity Record is installed and set up on each participating IBM z16 system.

- On the IBM z16 source system, the permanent capacity is unassigned to the base level.
- The new Flexible Capacity Record is installed and activated on the IBM z16 source system to restore capacity back to the purchased level.
- On the IBM z16 target system, the new Flexible Capacity Record enables clients to bring the capacity up to the level of the production system when activated. The Flexible Capacity Record remains inactive until capacity is shifted from the base system to the target system.
- After deactivating the Flexible Capacity Record on the base system, the capacity active through Flexible Capacity Transfer records on the target system is not permitted to exceed the capacity active on the base system before the shift.
- If GDPS automation is being used, it must be set up with the correct LIC records to add capacity in the target system and remove capacity in the base system site.

System Recovery Boost enhancements

System Recovery Boost for IBM z15 provided boosted capacity and parallelism to accelerate image-level recovery, such as shutdown and startup, and enabled accelerated processing of workload backlogs that occurred as a result of those image-level events following a re-IPL. System Recovery Boost also offered short-term recovery process boosts to mitigate certain Parallel Sysplex recovery impacts

and restore steady-state sysplex operation as quickly as possible, and to provide workload catch-up following the recovery. Participating images were eligible to receive an IPL boost of up to 60 minutes, an image shutdown boost of up to 30 minutes, and a pool of 30 minutes per image per day of recovery process boost time. System Recovery Boost provided additional image-level processing capacity and parallelism for the boosting images by making use of two underlying IBM z15 technologies: Speed Boost, enabling subcapacity GP processors to run at full-capacity speed, and zIIP boost, making general-purpose work eligible to run on zIIP processors.

On IBM z15, recovery process boosts could be provided for the following specific Parallel Sysplex recovery events:

- Sysplex partitioning boosts the planned or unplanned removal of a system from the sysplex.
- CF structure recovery boosts CF structure recovery processing, including CF structure rebuild and duplexing activities.
- CF data sharing member recovery boosts recovery following the termination of a CF locking data-sharing member with locks held.
- HyperSwap recovery boosts the HyperSwap recovery process to recover from the failure of a storage subsystem.

Now, with IBM z16, IBM extends the System Recovery Boost solution once more with additional recovery process boost use cases to provide value for a new set of recovery and diagnostic events, utilizing the same underlying boost technologies used previously. These new use cases are only available when running on IBM z16, or higher, systems.

These new solution enhancements provide boosted processor capacity and parallelism for the following specific events:

- **Client-selected middleware starts and restarts** boosts z/OS systems that are performing startup and restart for client-selected started-task middleware regions. By default, no middleware regions are boosted, but clients may configure this function for use by specifying which started-task middleware regions they want to be boost-eligible using WLM Service Definition Classification Rules. The recovery process boost is designed to expedite recovery for the middleware regions and restores steady-state operations as quickly as possible, with additional capacity for workload catch-up once the middleware region is started.
- **SVC dump processing** boosts z/OS systems that are performing diagnostic data capture through an SVC dump that is estimated to be over a certain size threshold. By default, no dumps will be boosted, but clients may configure this function for use by using the CHNGDUMP command to set a dump size threshold over which SVC dumps will be boosted. The recovery process boost is designed to minimize the impact of the SVC dump processing on your running workloads and provides additional capacity for workload catch-up following the completion of the SVC dump capture process.
- **HyperSwap configuration load and reload** boosts z/OS systems that are participating in a load or reload of a HyperSwap configuration policy. The recovery process boost is also designed to minimize the impact of the HyperSwap configuration change processing on your running workloads and provides additional capacity for workload catch-up following the completion of the configuration change process.

Note that these new IBM z16 recovery process boost use cases share the same recovery process boost time pool of 30 minutes per image per day with the Parallel Sysplex recovery use cases that were previously introduced on IBM z15. Furthermore, as was true previously, the use of System Recovery Boost Upgrade temporary capacity record activations for recovery process boosts is not supported. The System Recovery Boost Upgrade temporary capacity is for use only in conjunction with image-level IPL and shutdown boosts.

System reliability, availability, and serviceability

The IBM z16 platform builds upon the reliability, availability, and resilience of predecessor IBM Z server platforms. The intrinsic hard failure rate of the IBM Telum processor chip is at least three times lower than the prior-generation IBM z15 and is designed to reduce the number of recovery and service events over the life of the program. IBM internal laboratory tests were performed on pre-release IBM Telum processor chips to measure the intrinsic hard failure rate. *Results may vary.*

The cache structure is virtualized; the physical level of shared cache is implemented in a very robust SRAM wipe out correction and sparing design that benefits all virtualization levels. The cache allocation is fluid, dynamically changing the cache size and shape as needed, benefiting processor cores, CBU, and On/Off CoD.

The socket count per drawer is reduced with IBM z16, which simplifies structure and reduces the replaceable part count, which in turn simplifies service actions. The processor cores have expanded interleaving to improve resistance to soft error disturbances. Robustness has been improved as a result of simplifying uncorrectable error handling on many arrays. The memory DIMM has power conversion and regulation located on each DIMM, thereby allowing much tighter power tolerances, which improves reliability of the DRAM.

There are two data cables (SMP) between each drawer that enable workload to be routed to just one cable dynamically. As a result, applications can tolerate a cable with defective wires, and it enables a powerful new service function called concurrent cable repair. The cables have built-in shorts and configuration testing that help ensure the cable is properly plugged before you use it. An added benefit of concurrent cable repair is the reduction in the use of concurrent drawer repair.

The service network infrastructure has been refreshed with IBM z16, positioning the infrastructure for the future. The fill and drain tool water drain function has been improved to decrease the time needed to drain a part being replaced. This improvement is designed to also greatly reduce the time needed to drain the machine during the discontinuation process. The IBM z15 lift tool can be used for IBM z16. This reduces storage requirements for clients with servers on both platforms. Remote Code Load, available on IBM z16, reduces the need for IBM and customer service personnel onsite during firmware upgrades.

Quantum-safe protection

As quantum computing and the related rapidly developing ecosystem matures, the National Institute of Standards and Technology (NIST), as well as industry and academic institutions, are looking at the risk side of quantum technology. IBM recognizes that with any new technology, there are new threats, and as such, appropriate countermeasures may need to be taken.

Quantum technology can be used for incredible good, but in the hands of an adversary, it has the potential to weaken or break core cryptographic primitives that have previously been used to secure systems and communications. This leaves the foundation for digital security at risk. NIST initiated a process to solicit, evaluate, and standardize quantum-safe public-key cryptographic algorithms to address these issues. Quantum-safe cryptography aims to provide protection against attacks that can be initiated against classical and quantum computers.

IBM is a leader in the development of quantum-safe technology and the products that leverage this critical technology. IBM z16 quantum-safe technology enables you to act now to help future-proof your business.[2] IBM z16 leverages quantum-safe technologies to help protect your business-critical infrastructure and data from potential attacks.[2]

IBM z16 secure boot technology protects system firmware integrity by using quantum-safe and classical digital signatures to perform a hardware-protected verification of the Initial Machine Load (IML) firmware components.[2] This protection is anchored in a hardware-based root of trust for the firmware chain of trust.[2] IBM z16's quantum-safe technology is designed to provide a double layer of protection by using a dual signature scheme that employs classical and quantum-safe cryptographic algorithms to help ensure the server starts safely and securely

by keeping unauthorized firmware (malware) from taking over your server during system startup.[2]

Now is the time to start planning for the replacement of hardware, software, and services that use public-key and weak symmetric key cryptography. In addition to the cryptographic capabilities of IBM z16, tools will be provided that can help you discover where and what cryptography is used in applications to aid in developing a cryptographic inventory for migration and modernization planning. IBM z16 will enable future critical client use cases across many industries with the following capabilities:

- Quantum-safe key generation
- Quantum-safe encryption
- Quantum-safe key encapsulation mechanisms
- Quantum-safe hybrid key exchange schemes
- Quantum-safe dual digital signature schemes

IBM Application Discovery and Delivery Intelligence (ADDI) Version 6.1 helps you identify potential cryptographic exposures in your COBOL applications so you can easily identify vulnerable cryptographic calls and protect against harvesting of confidential data.

IBM z16 enables you to begin using quantum-safe cryptography along with classical cryptography as you begin to modernize existing applications and build new applications.[2] IBM z16 with Integrated Cryptographic Service Facility (ICSF), CEX8S, TKE 10.0, and other security features provide you the vehicle to take advantage of these quantum-safe capabilities.

Cryptographic enhancements for CCA and Enterprise PKCS #11 (EP11)

CCA CEX8S enhancements

IBM z16 delivers critical cryptographic capabilities that helps address the ever-changing security requirements across the globe around key management and distribution, data management and compliance, and protecting enterprise data. The new CEX8S is designed to meet the FIPS 140-3 at Level 4 for cryptographic modules. IBM's CCA 8.0 is designed to be certified to meet the HSM requirements from the PCI Security Standards Council (PCI SSC). Its unique design eases migration of applications and keys and expands to add new cryptographic algorithm support. CCA 7.0 through 7.4 also meet the PCI HSM requirements, with each release in process to receive certification as early as possible. CCA 8.0 also includes the enhancements from the release CCA 7.4.

The CEX8S with CCA firmware is designed to further offer enhancements that increase performance for both application workloads and TKE workstation domain group administration. The CEX8S with CCA firmware also has a redesigned queuing model that adds fairness for heterogeneous workloads originating from different domains.

CEX8S with CCA firmware includes complete AES-based financial services processing with complete ISO 4 PIN[(R)] block format and AES-DUKPT support. This includes the new PIN Verify 2 service, which allows secure comparison of ISO 4 PIN blocks to other PIN blocks inside the HSM. The AES processing updates are useful for payment network participants that are upgrading security to newer AES-based security protocols. Signature scheme support is enhanced with EdDSA (Ed448 and Ed25519) and Elliptic Curve Schnorr Digital Signature Algorithm (EC-SDSA), including the secp256k1 curve. The enhanced Elliptic Curve support is useful for protocols that require certificates or signature support using these curves. Data protection service is enhanced with X9.23 random pad for AES encryption services and format preserving encryption (FPE) support, including FF1, FF2, and FF2.1. The added FPE support is commonly used for communication of sensitive data between payment network participants, where the encrypted data must fit into fields and protocols that check the form and character set of the data. Key management is enhanced with X9 TR-31 support for HMAC keys, a PKCS#11 key export mechanism for CCA

keys that allows interoperation with various cloud services, and X9 TR-34 remote key exchange enhancements that allow better interaction with unique devices. CCA firmware is further enhanced with Australian financial services algorithm and protocol support for both issuer and acquirer workloads.

CCA quantum-safe cryptography enhancements

The CEX8S with CCA firmware has added secure key support for quantum-safe cryptography private keys for both signature and key encapsulation method (KEM) use cases. The CCA interface adds support for Cryptographic Suite for Algebraic Lattices (CRYSTALS) Dilithium secure private keys of sizes (6, 5) and (8, 7) for both round 2 and round 3 versions of CRYSTALS-Dilithium, usable for digital signature generation and verification. The CCA interface also adds support for round 2 of the CRYSTALS Kyber 1024 parameter set, a key encapsulation mechanism (KEM), which can be used to protect 32-byte values. These pieces are also combined with Elliptic-curve Diffie-Hellman (ECDH) support to offer clients a complete quantum-safe cryptography hybrid key exchange scheme, implemented with secure CCA private keys for all involved private keys. This is useful for scenarios where data needs enhanced authentication against future quantum computing attacks on conventional cryptography.

CCA - new TDES key block

CEX8S with CCA firmware contains enhancements also delivered for CEX7S after the IBM z15 GA1 on September 23, 2019. This includes the first proprietary TDES key block, also known as a key token, to be independently reviewed and confirmed to be compliant with PCISSC PIN Security key block requirements as updated September 30, 2020.

The new TDES key block is backward compatible with existing applications and Cryptographic Key Data Set (CKDS). The new TDES key block is implemented starting with z/OS level 2.4, ICSF HCR77D1, and APAR OA60318. The new TDES key block was available for IBM z15, IBM z14, and IBM z13$^{(R)}$ beginning July 2021 in the appropriate firmware drivers. The independent review is publicly posted. The new PCI PIN compliant CCA TDES key block is useful and required for applications that use TDES keys and cryptography in PCI PIN audited workflows.

EP11 CEX8S enhancements

CEX8S with Enterprise PKCS #11 (EP11) firmware offers enhancements that increase performance significantly in the areas of random number generation as well as message digest calculation.

It adds support for using the Secure Hash Algorithm 2 (SHA-2) and Secure Hash Algorithm 3 (SHA-3) families in conjunction with the RSA-OAEP encryption scheme, which has also been made available for the CEX7S with EP11 firmware since version 4.7.14.

CEX8S with EP11 firmware also adds general support for EdDSA (Ed25519 and Ed448) and ECDH with Montgomery curves (X25519 and X448), which has also been made available for the CEX7S with EP11 firmware since version 4.7.15.

EP11 quantum-safe cryptography enhancements

CEX8S with EP11 firmware has enhanced support for digital signatures with CRYSTALS Dilithium. Additionally, to the already existing security level 4 from round 2, the following security levels are now supported for generating and verifying quantum-safe signatures: round 2 (8, 7), round 3 (6, 5), and round 3 (8, 7).

It is also the first time that CRYSTALS Kyber for quantum-safe encryption and decryption as well as key encapsulation is supported with security levels 768 and 1024.

TKE 10.0 level of LIC

Important upgrade information: You can upgrade from TKE 9.x to TKE 10.0 with the purchase of a 4770 HSM for the TKE. However, you must update your workstation BIOS prior to the upgrade. To do that, you must install TKE 9.2 with the latest patches prior installing the TKE 10.0 firmware.

The TKE 10.0 level of LIC is required if you want to manage the CEX8S using the TKE. In addition, TKE 10.0 uses quantum-safe cryptography when the TKE authenticates CEX8S, derives Transport Keys between the TKE's HSM and the target CEX8S, and during the on-demand HSM dual validation check.

- TKE 10.0 has a domain group limitation. All the HSMs in a TKE domain group must all contain quantum-safe cryptography support (that is, only include CEX8S), or all the HSMs must not contain quantum-safe cryptography support (that is, the HSMs can't include any CEX8S).
- TKE 10.0 now supports one-time use MFA authentication on an open host.
- TKE 10.0 contains Configuration Migration Tasks support to enable you to collect and apply data to and from CEX8S and collect data from a pre-CEX8S HSM and apply it to CEX8S HSMs.
- TKE 10.0 supports a new default wrapping method for the CEX8S HSM.
- TKE 10.0 added support for a new AES DUKPT key attribute when using TKE to create AES DKYGENKY parts.

TKE 10.0 added support for the EP11 Outbound Authentication (OA) Signature Policy. The EP11 firmware on a CEX8S HSM enables users to configure what OA signatures are returned on responses from the HSM. The TKE OA Signature Policy controls what configuration options you may select when managing the settings from the TKE.

IBM Z Security and Compliance Center

In regulated industries, compliance is a top priority. But the process to collect evidence of information security controls and demonstrate compliance to auditors is manual and time-consuming.

Enterprise-grade security and resiliency features are architected throughout the IBM Z and Linux on IBM Z stack. The IBM Z Security and Compliance Center helps centralize monitoring of compliance related tacks and provides an interactive view of these tasks and potential severity of control deviations.

The IBM Z Security and Compliance Center is designed to help you streamline tracking and reporting of your internal compliance process as follows:

- Automate collection and validation of relevant facts from key areas of IBM Z/OS and Linux platforms, tracked over time with a browser based dashboard.
- Predefined profiles will identify potential deviations through built-in goal validation that help demonstrate to auditors the details around the severity of controls deviations from PCI-DSS and NIST SP800-53.

Enterprises using CICS Transaction Server for z/OS (CICS TS), Db2 for z/OS, MQ, or IBM Information Management System (IMS) will be able to use the IBM Z Security and Compliance Center dashboard to quickly and easily determine the extent to which their IBM Z systems meet internal controls and certain industry standards. CICS TS, Db2 for z/OS, MQ, and IMS runtimes will now provide additional information to z/OS to populate this dashboard.[*]

* Product update to the latest version may be required.

For more information about IBM Z Security and Compliance Center, see Software Announcement AP22-0005, dated April 05, 2022.

FICON Express32S

FICON Express32S supports a link data rate of 32 Gbps and autonegotiation to 16 Gbps and 8 Gbps for synergy with current-generation switches, directors, and storage devices. With support for native FICON, High Performance FICON for z Systems[R] (zHPF), and Fibre Channel Protocol (FCP), the IBM z16 server is designed to enable an end-to-end 32 Gbps infrastructure to meet the lower latency and increased bandwidth demands of your applications.

The FICON Express32S adapter will work with your existing fiber optic cabling environment, both single-mode and multimode optical cables. The FICON Express32S feature running at end-to-end 32 Gbps link speeds will provide reduced latency for large read and write operations and increased bandwidth compared to the FICON Express16SA and FICON Express16S+ features.

Throughput for the zHPF protocol

In laboratory measurements, using the zHPF protocol, a single IBM z16 FICON Express32S port delivers up to 5,400 MB/s for a mix of large data block (32 x 4 KB) read/write operations; a 68% increase over an IBM z15 FICON Express16SA port.

> Performance data for the FICON zHPF protocol was measured in a controlled environment on IBM z16 using a zOS I/O driver program to execute zHPF I/O operations on FICON Express32S. The FICON Express32S port operated at a 32 Gbps link data rate. The workload consisted of a mix of large (32 x 4 KB) sequential read and write data transfer I/O operations. *Results may vary.*

In laboratory measurements using the zHPF protocol, both ports on IBM z16 FICON Express32S deliver a total combined throughput of up to 9,000 MB/s for a mix of large data block (32 x 4 KB) read/write operations; a 38% increase over the total throughput of IBM z15 FICON Express16SA.

> Performance data for the FICON zHPF protocol was measured in a controlled environment on IBM z16 using a zOS I/O driver program to execute zHPF I/O operations on FICON Express32S. The FICON Express32S port operated at a 32 Gbps link data rate. The workload consisted of a mix of large (32 x 4 KB) sequential read and write data transfer I/O operations. *Results may vary.*

Throughput for the FCP protocol

A FICON Express32S adapter, when defined as CHPID type FCP, conforms to the FCP standard to support attachment of Small Computer Systems Interface (SCSI) devices, to complement the classical storage attachment supported by FICON and zHPF channels.

> In laboratory measurements, using the FCP protocol, IBM z16 FICON Express32S delivers up to 600,000 IOPS per port for small data block (4 KB) read operations; a 52% increase over IBM z15 FICON Express16SA. Performance results are based on laboratory measurements on IBM z16 using an internal Linux on IBM Z microbenchmark to execute FCP I/O operations on FICON Express32S. The FICON Express32S port operated at a 32 Gbps link data rate. The workload consisted of 4 KB read-only data transfer I/O operations. *Results may vary.*

In laboratory measurements, using the FCP protocol, a single IBM z16 FICON Express32S port delivers up to 6,400 MB/s for a mix of large data block (64 KB) read/write operations; 2x the throughput of an IBM z15 FICON Express16SA port.

> Performance results are based on laboratory measurements done on IBM z16 using an internal Linux on IBM Z microbenchmark to execute FCP I/O operations on a single FICON Express32S port. The FICON Express32S port operated at a 32 Gbps link data rate. The workload consisted of an even mix of 64 KB read/write data transfer I/O operations. *Results may vary.*

In laboratory measurements, using the FCP protocol, both ports on IBM z16 FICON Express32S deliver a total combined throughput of up to 9,700 MB/s for a mix of large data block (64 KB) read/write operations; a 54% increase over the total throughput of IBM z15 FICON Express16SA.

Performance results are based on laboratory measurements done on IBM z16 using an internal Linux on IBM Z microbenchmark to execute FCP I/O operations on both ports available on FICON Express32S. Both FICON Express32S ports operated at a 32 Gbps link data rate. The workload consisted of an even mix of 64 KB read/write data transfer I/O operations. *Results may vary.*

The FCP protocol is supported by z/VM, z/VSE$^{(R)}$, 21st Century Software VSE^{n}, and Linux on IBM Z. See the Software requirements section.

Cleaning discipline for FICON Express32S fiber optic cabling With the introduction of 32 Gbps link data rates, it is even more critical to ensure your fiber optic cabling infrastructure performs as expected. Proper fiber optic inspection, cleaning, and maintenance is required to help ensure that the data gets through. With 32 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 inspection and cleaning procedures in place.

Channel subsystem (CSS) scalability

The IBM z16 server, like the IBM z15 and IBM z14 servers, has support for six logical channel subsystems (LCSSs), which are required to support the 85 LPARs for IBM z16, and four subchannel sets per LCSS.

OSA-Express7S 1.2: an Ethernet technology refresh

The OSA-Express7S 25 Gigabit Ethernet short-range (25 GbE SR) feature was introduced on IBM z14, and with IBM z16 an additional long-range OSA-Express7S 1.2 25 GbE LR feature is being introduced to complete the full family of the OSA-Express7S generation of adapters along with a technology refresh of the entire OSA-Express7S 1.1 generation of adapters: 1000BASE-T Ethernet for copper environments along with 25 GbE SR, 10 Gigabit Ethernet (10 GbE), and Gigabit Ethernet (GbE) for single-mode and multimode fiber optic environments. The performance characteristics of the new features are comparable to their predecessor OSA-Express7S 1.1 features. They also retain the same form factor and port granularity, which is two ports per feature for the 1000BASE-T Ethernet and Gigabit Ethernet features, and one port per feature for the 10 Gigabit Ethernet and 25 Gigabit Ethernet features.

These members of the OSA-Express7S 1.2 family of features (#0454, #0455, #0456, #0457, #0458, #0459, and #0460) are exclusive to the IBM z16 family.

They are supported by z/OS, z/VM, z/VSE, 21st Century Software VSE^{n}, z/TPF, and Linux on IBM Z. See the Software requirements section for more information.

RoCE Express3: an RDMA/Ethernet technology refresh

The RoCE Express2 25 Gigabit Ethernet short-range (25 GbE SR) feature was introduced on IBM z14, and with IBM z16, an additional long-range RoCE Express3 25 GbE LR feature is being introduced along with a technology refresh of the existing single-mode and multimode fiber optic 10 GbE and 25 GbE offerings. The performance characteristics of the new features are comparable to their predecessor RoCE Express2 and RoCE Express2.1 features. They retain the same form factor and port granularity, which is two ports per feature for each of the 10 Gigabit Ethernet and 25 Gigabit Ethernet features.

These members of the RoCE Express3 family of features (#0440, #0441, #0452, and #0453) are exclusive to the IBM z16 family.

They are supported by z/OS, z/VM, Linux on IBM Z, and KVM (guest support through passthru or macvtap). For more information, see the Software requirements section.

IBM Z Monitoring Suite

IBM Z Monitoring Suite has been enhanced to support the new IBM z16 hardware with additional metrics and alerts for System Recovery Boost and CEX8S card status and performance. This can help enable users to take advantage of these new features with confidence that observability is provided by IBM monitoring tools.

IBM z16 Coupling and Parallel Sysplex enhancements and CFLEVEL 25 support

IBM z16 coupling hardware and firmware, including Coupling Facility Control Code (CFCC) CFLEVEL25, provides a variety of coupling facility (CF) and coupling link enhancements. New capabilities are provided for improved CF performance and scalability, technology and protocol upgrades for both short-reach and long-reach coupling links, simplified Dynamic CF Dispatching (DYNDISP), improved CF cache and lock structure resiliency, and new CF cache structure object residency time monitoring.

Coupling link short-reach protocol efficiency improvements

IBM z16 short-distance ICA SR coupling link protocols have been redesigned to provide reduced latency and improved CF service times for CF requests using these links. The improved CF service times for CF requests can translate into better Parallel Sysplex coupling efficiency and therefore may reduce software costs for the attached z/OS images in the Parallel Sysplex, as synchronous CF requests directly consume z/OS-image processor resources as they are executed. While the amount of improvement clients will see is highly dependent on various workload and configuration specifics, service times for short-distance CF read requests or lock requests may improve by up to 10%, write requests may improve by up to 25%, and duplexed write requests may improve by up to 25%, compared to CF service times on IBM z15 systems.[6]

Specific enhancements for IBM z16 have improved the short-distance coupling link data transfer protocols for CF requests that write data to the CF, have affinitized coupling link buffers to specific groups of coupling facility processors for more efficient execution, and have moved several performance-critical processes for both primary CF requests and secondary cross-invalidate (XI) and list-notification (LN) signals from the firmware into IBM z16 hardware.

These efficiency improvements are maximized when both ends of the coupling link connection reside on IBM z16 systems. However, some improvements are also realized when connecting an IBM z16 system to an IBM z15, IBM z14, or IBM z14 ZR1 generation system.

Short-reach coupling link adapters used on IBM z16 are compatible with existing short-reach coupling links on earlier-generation systems, such as ICA SR and ICA SR1.1 adapters. The existing CS5 coupling link type continues to be used, and short-reach coupling links can be connected from IBM z16 to earlier systems using existing cabling infrastructure.

CF image scalability improvements

IBM z16 coupling facility images are designed to provide improved CF image scalability compared to CF images on previous systems. The CF work manager has been redesigned to partition the available CF processors into small affinity groups of processors and then affinitize CF tasks and all task-related control blocks and data areas to a specific processor affinity group. Furthermore, incoming work received on coupling links and the link buffers associated with them are also affinitized to a specific processor affinity group. This tight relationship between incoming work, executing work, and CF processor affinity groups minimizes the costs of processor cache disruption and movement of CF commands from processor to processor within the CF image as the CF workload is executing, providing improved CF processor

scalability for IBM z16 CF images. The resulting effective CF scalability data for IBM z16 CF images will be incorporated into the zPCR and CP3000 capacity-planning tools for planning purposes.

On previous systems, some clients experienced growth constraints when trying to scale a CF image vertically by increasing the number of processors for the CF image beyond the number that would fit on a single processor chip. The scaling curve on earlier systems tended to flatten out when the CF processors spanned multiple processor chips, limiting the CF image's total capacity growth potential as processors were added. With the enhancements made for IBM z16, this flattening out of the scaling curve when the CF processors span multiple processor chips is greatly reduced, meaning that the effective capacity of IBM z16 CF images continues to increase meaningfully all the way up to the maximum of 16 processors in a CF image.

Additionally, to improve the vertical growth potential for IBM z16 CF images, the number of supported CF tasks that can execute concurrently is doubled from 112 to 224.

New adapter technology for long-reach coupling links

Long-reach coupling links on IBM z16 now make use of the new Coupling Express2 LR adapter, which provides technology upgrades and improved link throughput management protocols compared to previous generations of long-reach coupling links.

The new Coupling Express2 LR adapters are compatible with existing long-reach coupling links on earlier-generation systems using Coupling Express LR adapters. The existing CL5 coupling link type continues to be used, and long-reach coupling links can be connected from Coupling Express2 LR adapters on IBM z16 systems to Coupling Express LR adapters on earlier-generation systems using existing cabling infrastructure.

Note that Coupling Express LR adapters from previous machine generations cannot be carried forward to IBM z16. Only Coupling Express2 LR new-build adapters may be used to provide long-reach coupling connectivity for IBM z16 systems.

DYNDISP using thin interrupts required for shared-processor CF images

On IBM z15 systems, shared-processor CF images used thin-interrupt-based dispatching (DYNDISP THIN) by default, but support for the older DYNDISP OFF and ON dynamic dispatching options was still available for use. With IBM z16, DYNDISP THIN will be the only available dynamic dispatching option for use with shared-processor CF images. DYNDISP THIN uses interrupt-driven CF dispatching to provide the most efficient processor sharing for CF images, and the best overall shared-processor CF performance and service times. If either DYNDISP OFF or ON is specified for use on an IBM z16 CF image, a warning message will indicate that the CF image will use DYNDISP THIN instead.

Note that for production environments, the use of dedicated-processor CF images remains highly recommended to provide the best possible CF image performance and service times.

CF structure sizing increases for CFLEVEL 25

When migrating coupling facility images to a new, higher CFLEVEL, clients should always make use of the CF Sizer web-based CF structure sizing service at https://www. ibm.com[(R)]/support/pages/cfsizer. Alternatively, you can use the batch SIZER utility, which may be downloaded from the CF Sizer website, to recalculate CF structure sizes for the new CFLEVEL and make the corresponding changes to their Coupling Facility Resource Management (CFRM) policy INITSIZE or SIZE specifications. CF structure memory size requirements often increase when migrating to a higher CFLEVEL.

IBM z16 CFLEVEL 25 is no exception to this general rule, and in fact the structure size increases may be more noticeable going to CFLEVEL 25 than for some previous

CFLEVEL migrations, particularly for structures whose absolute size is small (e.g., 100 MB or less). Clients are urged to carefully resize their CF structures as part of migrating to CFLEVEL 25.

Connectivity considerations and supported maxima

IBM z16 provides coupling link n/n-2 connectivity and Parallel Sysplex n/n-2 hardware coexistence with the IBM z15, IBM z14, and IBM z14 ZR1 generations of IBM Z servers.

The use of IBM z13-generation and IBM z13s$^{(R)}$-generation systems, or earlier systems, in the same Parallel Sysplex configuration with IBM z16 systems is not supported. As was true on IBM z15 systems, IBM z16 continues to provide support for a maximum of 384 coupling CHPIDs per CEC/system, a maximum of 64 ICP internal coupling CHPIDs per CEC/system, and a maximum of 4 CHPIDs per coupling link port.

Server Time Protocol (STP): time synchronization for Parallel Sysplex

STP is designed to allow events occurring in different IBM Z, Linux on IBM Z, or LinuxONE servers to be properly sequenced in time by synchronizing the clocks of those servers. STP is designed for servers that have been configured in a Parallel Sysplex or a basic sysplex (without a coupling facility), as well as servers that are not in a sysplex but need time synchronization.

STP is a server-wide facility that is implemented in the LIC, presenting a single view of time to the Processor Resource/Systems Manager (PR/SM). STP uses a message-based protocol in which timekeeping information is passed over externally defined coupling links between servers. The STP design introduced a concept called Coordinated Timing Network (CTN), a collection of servers and CFs that are time-synchronized to a time value called Coordinated Server Time (CST). The CTN is able to maintain synchronization to Universal Coordinated Time (UTC) through network connectivity and a time synchronization protocol to an external time reference receiving a time signal traceable to UTC.

For IBM Z machines prior to IBM z15, this external time reference would typically be Network Time Protocol (NTP). Starting with IBM z15, this external time reference could also be IEEE 1588 Precision Time Protocol (PTP). Prior to IBM z16, the external time reference network connectivity occurred through the SE Service Word Interface and the internal service network. For clients requiring accuracy to UTC of 100 milliseconds or less, pulse per second (PPS) connectivity is also available.

Direct-connect for STP external time reference

With this announcement, IBM z16 introduces a new, enhanced method for connecting to a CTN's external time reference. IBM z16 introduces support for connecting the CEC directly to PTP or NTP external time references through your data center network. For example, bypassing the service word interface and internal service network. PTP or NTP traffic will now come into the CEC through Ethernet connectivity to a new adapter card that is in turn connected directly to IBM z16 oscillators. This new adapter card features hardware timestamping capabilities, allowing IBM z16 to take full advantage of the accuracy of PTP. It is expected that these enhancements will result in STP being capable of significantly enhanced accuracy to UTC compared to previous IBM Z machines and possibly eliminate the future need for PPS connectivity. Many clients are subject to UTC accuracy regulations, which the enhancements to the external time reference may help you meet. These regulations include the European Securities and Markets Authority (ESMA) directive on markets in financial instruments (MiFID 2) Regulatory Technical Standard (RTS) 25. The regulations also include the US Financial Industry Regulatory Authority (FINRA) rules on financial transaction timing accuracy and the Securities and Exchange Commission (SEC) Rule 613 Consolidated Audit Trail (CAT). Better UTC time accuracy against the external time reference also implies better UTC time accuracy compared to the distributed systems servers, getting tighter time synchronization between all systems involved in the financial transactions systems.

IBM z16 sustainability

IBM has a longstanding commitment to building a more sustainable, equitable future. Back in 1971, IBM formalized its environmental programs and commitment to leadership with the issuance of its Corporate Policy on IBM's Environmental Responsibilities. This was a quarter century before the first International Organization for Standardization (ISO) 14001 environmental management systems standard was published. IBM's activities between then and 2021, when IBM committed to reaching net zero greenhouse gas emissions by 2030 in all 175 countries in which it operates, make it an ideal partner for the increasing number of businesses that consider sustainability a strategic direction. For more information, see the IBM Commits To Net Zero Greenhouse Gas Emissions By 2030 web page.

Continuing in that same spirit, IBM Z is the ideal platform for achieving corporate sustainability goals. Continuing the 25-year history of improved sustainability factors, such as increased system capacity per kW, in every release, IBM z16 is designed to enable even greater sustainability success for businesses.

IBM z16 is built for the modern data center to optimize flexibility and sustainability. An IBM z16 system using the Intelligent Power Distribution Unit (iPDU) power option is designed to save considerable energy compared to IBM z14 and IBM z15 systems utilizing bulk power technology. With the introduction of on-chip AI acceleration, IBM Z continues to deliver key architectural advantages to support your organization's sustainability goals, including:

• Data center modularity and flexibility
• Specialty engines to offload I/O processing and perform on-chip AI and encryption
• Ability to sustain high CPU utilization
• High reliability and availability, which increases the lifespan of the hardware

These key architectural advantages help make IBM z16 a differentiator in your data center when it comes to sustainability benefits.

IBM continues to focus on environmental design for its products and provides resources to help businesses quantify the impacts. IBM z16 makes available product carbon footprint reports using the Product Attributes to Impact Algorithm (PAIA) to help businesses understand the lifecycle carbon sustainability of the IBM Z hardware within their data centers. IBM z16 provides telemetry information that is useful for the integration into modern data center infrastructure management (DCIM) systems through a set of secure, REST-based web service APIs. IBM z16 environmental telemetry aligns with the latest ASHRAE Tier 1 DCIM Compliance.

The combination of these IBM z16 enhancements with IBM Z's existing sustainability benefits, and also having IBM's overall commitment to sustainability in your corner, means that having an IBM z16 system in your data center will go a long way toward helping you meet your sustainability goals.

Modernize for hybrid cloud

Today's IT leaders are driving new value and differentiation from their core business applications and data by employing a modernization strategy that supports a larger hybrid cloud strategy across their IT landscape.

IBM z16 is designed to be the premier hybrid cloud and AI transactional platform to support that hybrid cloud strategy. IBM z16 is designed to deliver unparalleled value and choice to clients with flexibility for the future beyond what prior generations of IBM Z provided. IBM z16 is designed to bring significant differentiated value to clients by infusing AI at every level of workload and data across hybrid cloud for the most vital workloads driving the globe. Differentiation comes from unmatched support for data gravity between applications and data co-located on IBM z16 systems across Linux on IBM Z and z/OS, achieving real-time AI at scale, and providing you with intelligent and trusted systems and platforms.

Building on this solid foundation of trust and expertise while coupling IBM z16 with Red Hat OpenShift as the innovative, hybrid, multicloud platform built on open source provides a flexible hybrid cloud solution that embraces client choice. With IBM Z and cloud together, clients may lower cost, reduce risk, and help ensure business continuity while supporting modernization and digital transformation initiatives.

IBM z16 and cloud together is the better architecture for business innovation, because it takes a platform approach to provide a single integrated fabric across all those silos. You can have a common cloud experience that enables consistent, agile practices, which supports interoperability and secure integration of workloads and data from on IBM z16 across hybrid cloud, regardless of where the capabilities are required.

IBM z16 and supporting IBM Z and Red Hat software provide an unprecedented combination of speed, reliability, and security along with a cloud-native experience centered on industry standards, open tools, and pioneering intelligence. This combination delivers an open and flexible architecture that helps empower clients to use the best fit IT for their business needs to deliver more value than a public cloud-only approach.

The new IBM z16 and supporting IBM Z and Red Hat software can help businesses:

- Simplify access to applications and data through secure API creation and integration in minutes
- Leverage agile enterprise DevOps for cloud-native development with open tools and rapid application analysis
- Standardize IT automation to empower developers with access to open source environments and IBM z16 resources
- Adopt the right modernization approach for each workload to help ensure cost and value are aligned
- Enable tighter integration of workloads with a consistent cloud experience
- Automate processes and deliver intelligent operations for productivity, efficiency, and innovation

IBM z16 helps empower businesses to do this and more through the power of IBM Z and the cloud, where they can leverage agile practices and adopt a "build once, deploy anywhere" approach across a hybrid infrastructure.

z/OS support for IBM z16

New functions in z/OS continue to enhance the role of IBM Z with support for IBM z16 in helping you provide solutions with breakthrough technologies for your critical workloads.

z/OS support for the IBM z16 IBM Z Integrated Accelerator for AI

The IBM Z Integrated Acceleratorr for AI is an on-chip inference accelerator in IBM z16. The z/OS's new zDNN library provides APIs and a toolkit to drive the integrated accelerator for AI through a new NNPA facility instruction, which drives the integrated accelerator for AI.

The zDNN provides support for an exploiter to transform tensor memory layout from standard layout to nonstandard layout, which is required by NNPA. zDNN also provides support for an exploiter to convert tensor element data type from standard types to the NNPA required DLFloat16 format and call deep learning primitives supported on NNPA.

The zDNN is available on both z/OS and Linux on IBM Z distributions. Linux on IBM Z facilitates zCX exploitation of the integrated accelerator for AI when using supported Linux AI frameworks. Exploiters on servers without the integrated accelerator for AI are expected to provide an alternate implementation of primitives. The zDNN is provided on z/OS 2.4, and later.

z/OS support for IBM z16 System Recovery Boost enhancements

As described above, with IBM z16, System Recovery Boost provides support for three new z/OS-oriented use cases for short-duration recovery process boosts:

- SVC dump processing
- Client-selected middleware starts and restarts
- HyperSwap configuration load and reload

z/OS provides the necessary administrative and operational controls in CHNGDUMP to manage which SVC dumps may receive a boost, and in the WLM Service Definition Classification Rules to manage which middleware starts and restarts may receive a boost. Additionally, when running on IBM z16, z/OS display commands for System Recovery boost are enhanced to provide additional information about the current usage of the recovery process boost time pool that is available to the z/OS image, and when that time pool will be refreshed.

In addition to these IBM z16-specific enhancements, z/OS provides new System Recovery Boost support for dynamically enabling and disabling recovery process boosts for all use cases, which clients can use to better control how the system makes use of the available recovery process boost time. Furthermore, z/OS is providing improved display, monitoring, and SMF logging capabilities that cover both the actual and potential use of recovery process boost time to assist clients in managing and understanding the usage of recovery process boost time in their z/OS images.

The z/OS software support for IBM z16 System Recovery Boost requires PTFs for z/OS 2.4 or 2.5. The z/OS PTFs will be included in a z/OS FIXCAT designated specifically for System Recovery Boost support, named "IBM.Function.SystemRecoveryBoost".

z/OS support for IBM z16 CPACF counters

With IBM z16, IBM provides processor activity instrumentation to count cryptographic operations.

SMF 0 records have been enhanced to indicate the number of crypto counters supported by the current IBM Z hardware.

SMF 30 records have been enhanced to include new crypto counter sections that contain counters for CPACF cryptographic instructions utilized by a job in a given period. These sections are produced only for those instructions that are used. These counters are correlated with z/OS jobs and users for the determination of the algorithms, bit lengths, and key security utilized by a given workload. This data can aid in compliance, performance, and configuration.

- The SMF 30 self-defining section indicates the length and number of crypto counter sections.
- The SMF 30 product/subsystem section indicates if the crypto counters are active.

This feature is supported on z/OS 2.4, and later. It requires APAR OA61511.

z/OS support for compliance

z/OS has been enhanced to enable the collection of compliance data from IBM z16 CPACF counters and several z/OS products and components. A new z/OSMF Compliance fact collection REST API sends an ENF86 signal to all systems. Participating products and components will collect and write compliance data to new SMF 1154 records associated with its unique subtype. These new SMF 1154 records may be integrated into solutions such as the IBM z16 IBM Z Security and Compliance Center.

This support requires PTFs for z/OS 2.4 and z/OS 2.5. The PTFs will be identified by fix category designated specifically for compliance data collection support named

"IBM.Function.Compliance.DataCollection". See IBM Fix Category Values and Descriptions for information on how to use this fix category to identify and install the specific PTFs that enable compliance data collection.

For additional information about z/OS collection sources and enablement, see:

- IBM Z Security and Compliance Center, Software Announcement AP22-0005, dated April 05, 2022.
- CICS Transaction Server for z/OS 6.1, Software Announcement AP22-0089, dated April 05, 2022.
- Db2 13 for z/OS powered by AI innovations provides industry scalability, business resiliency and intelligence, Software Announcement AP22-0003, dated April 05, 2022.

Compiler support for IBM z16

A key strength of the IBM enterprise compilers, Enterprise COBOL, Enterprise PL/I, and XL C/C++, is the continual support of the latest IBM Z hardware architectures. The latest releases of the compilers (Enterprise COBOL for z/OS 6.4, Enterprise PL/I for z/OS 6.1, and the new Open XL C/C++ 1.1 for z/OS component) make available the ARCH(14) option to exploit the new hardware instructions available on the IBM z16. Application developers can recompile using the new ARCH(14) compiler option to instruct the compiler to generate code to exploit instructions available on IBM z16. This translates into immediate support of IBM z16 and improved application performance without any source code changes.

IBM Open XL C/C++ 1.1 for z/OS is the newest XL C/C++ compiler that is based on the open source LLVM infrastructure. It supports up to the latest C17 and C++17 language standard features, and the latest hardware exploitation capabilities - including exploitation of the latest IBM z16. It is a 64-bit only compiler that runs on z/OS UNIX$^{(R)}$. Clients can download this web deliverable and run it on zOS 2.4 and 2.5.

The latest releases of IBM SDK Java^{TM} Technology Edition 8, and IBM Semeru Runtime Certified Edition 11, for Linux on IBM Z and z/OS supports and exploits IBM z16. Powered by Eclipse OpenJ9 technology, the Java Virtual Machine detects the underlying hardware and optimizes existing Java application code with transparent exploitation of new IBM z16 hardware instructions.

IBM Semeru Runtime Certified Edition for z/OS is a new, high-performance 64-bit Java runtime and development kit on z/OS. It supports the new Java 11 language features and includes the OpenJDK Java 11 class libraries and the Eclipse OpenJ9 JVM. Clients can now develop Java applications using Java 11.

The latest release of IBM Automatic Binary Optimizer for z/OS (ABO) 2.2 makes available a new ARCH(14) option to exploit the instructions available on IBM z16. Using ABO 2.2 to optimize existing VS COBOL II 1.3 to Enterprise COBOL 6.4 modules allows these modules to obtain improved computation performance without the need for recompilation.

Open Enterprise Languages --IBM Open Enterprise SDK for Node.js, IBM Open Enterprise SDK for Python, IBM Open Enterprise SDK for Go, and IBM Open XL C/C++ on z/OS support the current open source language levels and are enabled to run natively on z/OS. They provide new and exciting application modernization options for clients. Performance can also be optimized by co-locating applications written in these languages with core applications and data on IBM Z.

CF cache and lock structure resiliency improvements

IBM z16 CFLEVEL 25 support provides improved resiliency support for CF cache and lock structure usage. The CF now implements a functional retry buffer capability that applies to the subset of CF cache and lock commands that are not perfectly able to be safely retried when an interface control check (IFCC) or other link-related error interrupts the normal request flow to or from the CF image. Retry buffers make it possible for z/OS to always determine the outcome of such CF operations following a transient link error, avoiding any ambiguities related to the CF structure

updates made by those requests. z/OS makes use of CF retry buffers to improve the resiliency of these CF structure operations without requiring any software updates by the user function that is exploiting the CF structure for its data-sharing purposes.

z/OS APAR OA60275 provides the z/OS operating system support for retry buffer enhancements for z/OS 2.2 through 2.5.

Additionally, IBM z16 CFLEVEL 25 provides lock structure exploiters with the new capability to dedicate a subset of lock structure record data entries that are reserved for recovery use only. Exploiters may reserve these record data entries and thereby ensure that even when all of the normal record data entries in a lock structure have been used up, the special pool of dedicated recovery-use entries still remain available for use in recovering from this structure-full condition.

z/OS APAR OA60650 provides the z/OS operating system support for reserved lock structure record data entries for z/OS 2.3 through 2.5.

CF cache structure object residency time monitoring and metrics

New CF cache structure monitoring and metrics are provided for IBM z16 CFLEVEL 25 coupling facilities. These metrics provide cache structure exploiters with additional cache object information that can be used to provide improved cache management, either directly by the exploiter or through improved cache usage reporting by the exploiter. New storage class statistics are provided to report on cache directory entry and data area "residency times," defined as the average time between when a cache directory entry or its associated data area are first created, until the time that those cache structure resources are reclaimed for use to satisfy a more-current cache structure request. Residency time metrics can be used to provide insights into the overall cache effectiveness for CF cache structures.

z/OS APAR OA60650 provides the z/OS operating system support for cache structure object residency time metrics for z/OS 2.3 through 2.5.

z/OS upgrade improvements for IBM z16

IBM is making continual enhancements with assistance in z/OS upgrades for the new IBM z16 server. The z/OS IBM z16 Upgrade Workflow, which provides all the necessary information to position z/OS on the IBM z16 server, will be provided in a z/OS program temporary fix (PTF), which has been identified with the SMP/E FIXCAT IBM.Device.Server.z16-3931.RequiredService. Any updates and fixes for the z/OSIBM z16 Upgrade Workflow will be provided with PTFs and service supported through the standard IBM z/OS service process. By including the z/OS IBM z16 Upgrade Workflow both in the z/OS product and in an exported form on the Abstract for the z/OS Upgrade Workflow web page, this important technical material is conveniently available for use while preparing for and learning about your upgrade to IBM z16.

z/OS identifying and installing PTFs for IBM z16

z/OS support is delivered in service (PTFs) for IBM z16, which have been identified using SMP/E fix categories (FIXCATs). These FIXCATs can be used to identify minimum required service, additional recommended service, and service needed for exploitation.

The minimum required PTFs for z/OS have been identified with the SMP/E FIXCAT IBM.Device.Server.z16-3931.RequiredService

PTFs that are recommended to be installed by the IBM service organization are identified with the SMP/E FIXCAT IBM.Device.Server.z16-3931.RecommendedService

IBM z16 exploitation functions, which you may choose to use later after your initial upgrade, have been identified with the SMP/E FIXCAT IBM.Device.Server.z16-3931.Exploitation

Use the SMP/E REPORT MISSINGFIX command with the latest Enhanced HOLDDATA to quickly and easily identify any PTFs that are missing on your system for the category in which you are interested.

IBM Container Hosting Foundation for z/OS 1.0.0

IBM Container Hosting Foundation for z/OS is a z/OS software product (5655-HZ1) that satisfies licensing for the enablement of IBM Z Container Extensions (zCX). IBM Container Hosting Foundation for z/OS is required to run zCX on IBM z16.

IBM zCX Foundation for Red Hat OpenShift (5655-ZCX)

The introduction of zCX provided z/OS clients with an OCI container-based software solution to run their Linux on IBM Z software directly on z/OS. This extends Linux application deployment capability to z/OS clients who join traditional Linux on IBM Z clients and LinuxONE clients.

Red Hat OpenShift is an enterprise-ready Kubernetes container platform built for an open hybrid cloud strategy that provides a consistent application platform to manage hybrid cloud, multicloud, and edge deployments. Red Hat OpenShift on z/OS, using zCX, enables clients to leverage the power of OpenShift with the power of z/OS. This results in application deployment and management of OpenShift with the ability to co-locate applications and workloads that have an affinity for z/OS by bringing those applications and workloads closer to z/OS applications and data.

The availability of Red Hat OpenShift on z/OS with zCX enables a strong union between z/OS and the container orchestration benefits of Red Hat OpenShift. It enables clients to take advantage of the Red Hat OpenShift Container Platform while exploiting z/OS qualities of service, such as scalability, availability, integrated disaster recovery, backup, workload management, and integration with z/OS security.

IBM z/OS Change Tracker: complementary resiliency feature availability

As IBM continues to provide a suite of robust tools to help system programmers manage z/OS, IBM is also offering IBM z/OS Change Tracker, a comprehensive configuration change management tool for tracking, controlling, and managing changes in software, as a priced feature of z/OS 2.5.

With a simple control interface to identify, manage, and audit configuration files, the z/OS Change Tracker is planned to help clients with all aspects of the change configuration management experience, including software management and resiliency. Today, monitoring hundreds of configuration files can be a manual and tedious process, making it difficult to do without the right tools and leaving the potential for undesired system configuration changes. z/OS Change Tracker is also planned to help system programmers quickly understand the differences between two groups of data sets or volumes to see if deployment of software has resulted in identical copies.

For more information about z/OS Change Tracker, see Software Announcement AP22-0013, dated April 05, 2022.

z/VM support for IBM z16

The z/VM 7.1 and z/VM 7.2 PTFs for APAR VM66532 provide support to enable guests to exploit function on IBM z16, including:

- Imbedded AI acceleration designed to reduce the overall time required to execute CPU operations for neural networking processing functions and to help support real-time applications like fraud detection.
- Compliance-ready CPACF counter support, which provides a means for guests to track cryptographic compliance and instruction use.
- Breaking Event Address Register (BEAR) enhancement facility designed to improve the ability to debug wild branches.

- Vector packed decimal enhancements 2, which deliver new instructions intended to provide performance improvements.
- Reset DAT Protection facility designed to provide a more efficient way to disable DAT protection, such as during copy-on-write or page change tracking operations.
- Support for the consolidated boot loader designed to provide guest IPL from a SCSI LUN. Note that guest IPL from SCSI, with or without the DUMP option, will now require a minimum guest virtual memory size of 768 MB.
- RoCE Express3 adapter, enabling guests to exploit Routable RoCE, Zero Touch RoCE, and SMC-R V2 support.
- CEX8S adapter supported as a dedicated or shared resource. Dedicated guests will be able to take advantage of all functionality available with the CEX8S adapters, including assorted new enhancements and use of quantum-safe APIs.[3]

The PTFs for APAR VM66532 also support CPU/Core topology location information that will be included in z/VM monitor data, providing a better picture of the system for diagnostic and tuning purposes.

The following infrastructure support must be installed on all members within an z/VM Single System Image (SSI) cluster before any member of the cluster is IPLed on IBM z16:

- z/VM 7.2 with the PTF for APAR VM66504
- z/VM 7.1 with the PTFs for APARs VM66206 and VM66504

All IBM z16 compatibility support will be in the base of z/VM 7.3. For additional information on z/VM 7.3, see Software Announcement AP22-0099, dated April 05, 2022.

For further details, review the z/VM website at https://www.vm.ibm.com/service/vmreqz16.html and the hardware PSP bucket 3911DEVICE z/VM subset.

z/VM new function portal

The z/VM Continuous Delivery News web page is the primary vehicle used by IBM to describe new functions that are planned for z/VM. It is the recommended way to keep track of future development and support plans for the z/VM product. z/VM clients should consider subscribing to this page. Instructions are included on the VM Site File Change Notification web page.

Select z/VM 7.2 enhancements delivered during 2021

The following z/VM 7.2 enhancements were delivered during 2021 and provide additional IBM z16 benefit for z/VM workloads:

- 4 TB real memory support: With the PTF for APAR VM66173, z/VM delivers support for up to 4 TB of real memory, allowing z/VM systems to address a full 4 TB of first-level (real) memory, doubling the previous supported limit of 2 TB.
- Dynamic Memory Downgrade support:

  With the PTF for APAR VM66271, Dynamic Memory Downgrade extends the real storage dynamic management characteristics of z/VM by allowing up to 50% of the real memory to be removed from a running z/VM system. A minimum hardware bundle level is required to avoid a possible downgrade stall.

  For additional details, see https://www.vm. ibm.com/memman/dmd.html.
- Improved Live Guest Relocation for shared cryptography users: With the PTF for APAR VM66496, Live Guest Relocation for APVIRT cryptographic environments is enabled when the type of shared cryptographic resource on the source system does not match the type on the target system.
- z/XC support:

  With the PTFs for APARs VM66201 (CP), VM66425 (CMS), and VM66489 (Perfkit), z/Architecture Extended Configuration (z/XC) support is provided. Conversational Monitor System (CMS) applications that run in z/Architecture can use multiple address spaces. Programs can use z/Architecture instructions and

registers, within the limits of z/CMS support, and can use VM data spaces in the same CMS session.

IBM z16 requires z/CMS and z/XC support to be configured within guest virtual machines that exploit z/VM HCD support. In addition, once applied, the PTF for IOCP APAR VM66549 will require z/CMS support on any IBM Z or LinuxONE server. IOCP support is in the base of z/VM 7.3 and requires z/CMS.

- Direct-to-Host Service Download support:

  With the PTF for APAR VM66540, z/VM 7.2 provides an optional way to download service to your z/VM system. A web interface simplifies the downloading of z/VM service that was ordered through IBM Shopz. The service files can be transferred through direct-to-host connection.

VSE support for IBM z16

z/VSE 6.2 and its standalone utilities run entirely in z/Architecture mode.

21st Century Software VSE^n 6.3 and its standalone utilities run entirely in z/Architecture mode.

1 ITIC 2021 Global Server Hardware Server OS Reliability Report, June/July 2021.

2 IBM z16 with the Crypto Express8S card offers quantum-safe APIs that provide access to quantum-safe algorithms, which have been selected as finalists during the PQC standardization process conducted by NIST Information Technology Laboratory. Quantum-safe cryptography refers to efforts to identify algorithms that are resistant to attacks by both classical and quantum computers, to keep information assets secure even after a large-scale quantum computer has been built. Source: ETSI Quantum-Safe Cryptography (QSC). These algorithms are used to help ensure the integrity of a number of the firmware and boot processes. IBM z16 is the industry-first system protected by quantum-safe technology across multiple layers of firmware.

5 Based on internal measurements. Results may vary by customer based on individual workload, configuration, and software levels. Visit LSPR website for more details at: https://www-40. ibm.com/servers/resourcelink/lib03060.nsf/pages/lsprindex.

6 Measurements were done with an IBM internal workload generating a representative mix of coupling facility requests on an IBM z16 running two z/OS partitions with 16 GCPs on each partition and coupling facility image(s) with 4 ICFs each running at about 30% utilization. Measured with shared ICA-SR links. The amount of improvement will vary based on workload and configuration.

HMC 2.16.0 highlighted feature enhancements

- *HMC security enhancements:*

  – *Additional MFA-supported types and support of additional z/OS environment*

    Previously, the HMC provided support for MFA types of Time-based One-Time Password (TOTP) and RSA SecurID. HMC 2.16.0 will now provide support for additional MFA types of the following using a server connection to the IBM Z MFA component running in an IBM Z operating system:

    Generic RADIUS - enables support of all various Remote Authentication Dial-In User Service (RADIUS) factor types; Certificates - Personal Identity Verification (PIV) and Common Access Card (CAC)

    Previously, the HMC only supported connections to the IBM Z MFA component in z/OS, and now the HMC 2.16.0 will support connections to the IBM Z MFA component running in z/VM$^{(R)}$ and Linux$^{(R)}$ on IBM Z.

  – *PCI-DSS compliance for HMC logon*

    HMC 2.16.0 logon controls are being enhanced to address security standards for PCI-DSS.

  – *TLS 1.3 support*

HMC 2.16.0 will support TLS 1.3 as well as TLS 1.2.

Clients can choose to only support TLS 1.3 for HMC/SE, but prior to doing so, clients must ensure that all services or servers connecting through the TLS to the HMC/SE support TLS 1.3. These include remote browsing workstations, LDAP authentication servers, WebServices API connections, Fibre Channel End Point Security, FTPS servers, and Single Object Operations.

Note that TLS 1.0 and TLS 1.1 support will be removed for 2.16.0 HMCs/SEs. Clients must ensure all connecting servers support TLS 1.2 or TLS 1.3.

– *Reduction of default users shipped with HMC/SE, all default users password change*

In 2020, California instituted an IoT password law requiring any default shipped passwords to be changed on installation or unique per device shipped. This same type of requirement is expanding worldwide, and starting with IBM z16, HMC/SE will require new IBM Z systems default user password changes for all IBM z16 systems.

To help manage this requirement, the HMC/SE will limit default user IDs or requirement to ACSADMIN and SERVICE.

ADVANCED, OPERATOR, STORAGEADMIN, and SYSPROG default users will no longer be shipped.

Default user roles for ADVANCED, OPERATOR, STORAGEADMIN, and SYSPROG will be shipped, and user IDs can be created from those. Any default user IDs that are part of a previous HMC level can be carried forward to new HMC levels as part of a MES Upgrade or through the selection of User Profile Data for the Save/Restore Customizable Console Data or Configure Data Replication tasks.

As part of the IBM z16 installation, HMC/SE ACSADMIN and SERVICE users will be required to make a password logon change on their first user logon.

Clients are responsible for maintaining passwords, and they especially need to establish a plan for service users.

Clients should be ready to provide the user ID and password to an IBM Service Support Representative (SSR) upon arrival to the IBM System when servicing the IBM Z after the initial installation.

Note that IBM recommends that clients maintain a list of unique service IDs and passwords to accommodate different SSRs servicing the system and avoid sharing user IDs. It is imperative to establish a user ID and password handling process to avoid any delay of service.

– *Changed default certificate expiration*

Newly created HMC/SE certificates will now have a default expiration of 398 days, which is being driven by industry security requirement. Clients have the option to modify that expiration time.

HMC/SE enhancements have been made to notify clients by a Hardware Message starting at 90 days and other subsequent various days prior to expiration.

Clients certificates managed by the HMC/SE include uses for browser, WS APIs, HMCmobile, remote syslog server, Fibre Channel End Point Security, Remote Support Facility (RSF) proxy, and MFA.

• **HMC Workspace enhancements:**

– *The HMC dashboard replaces the HMC Home tab's Welcome node*

The toolbar at the top will contain the Helpful link and HMC information. In addition, that HMC dashboard will contain the following four HMC widgets, which provide optional and simplified views of previous actions without a

significant overhaul of the entire HMC user experience. Additional widgets are expected to be added in the future.

1- What's new; 2-Systems health; 3-Hardware messages; 4-Frequently used tasks

– *n-mode Power STP Imminent Disruption Signal option*

On IBM Z, losing a Preferred Time Server (PTS) has significant consequences to the timing network and the overall workload execution environment of the IBM Z sysplex. The IBM Z and the HMC have had longtime automated failover protection for various cases that can arise.

However, for IBM z16, since there is no longer an integrated battery facility, support was added by the HMC to allow the client to configure an option to monitor for n-mode power conditions (wall power or line cord loss), and if detected, an automated failover will occur to the Backup Time Server (BTS). Note that you should provide some backup power method to hold power for 60 seconds on the PTS to allow failover to successfully complete.

There are also Manage System Time user interface controls to manage to failback to the PTS when the full power state is restored. There are also HMC System Events for client awareness through user interface or automation.

– *Base Control Program internal interface (BCPii) enhancements*

HMC support of BCPii is being enhanced to provide suspend and resume notifications to the operating system side of BCPii when the SE is rebooted for a firmware update, as well as other more rare recovery conditions of when an SE reboot could occur. GDPS$^{(R)}$ will utilize these notifications to generally eliminate BCPii requests while the SE is away. System Automation Processor Operations (SA Proc Ops) and the client's own BCPii automation can also utilize these new notifications.

The HMC is also adding resiliency for BCPii communication by monitoring for additional conditions of early warning of potential communication issues and executing methods of automatic recovery.

– *HMC Data Replication enhancements*

The HMC Data Replication support provides an underlying communication framework to allow you to configure user management and associated activation profiles, monitor system event notifications, and access other various controls on a single HMC, and then replicate that to other HMCs so that users only have to do the configuration or customization actions once.

The HMC 2.16.0 has been enhanced to ensure when replication is active, that replication data can only be customized by the user on a primary or peer HMC. Replication data can no longer be changed by a user or automation on a replica HMC other than by the HMC Data Replication framework.

In addition, the HMC Configure Data Replication task is enhanced to have a panel design similar to other HMC wizard tasks, which guide the user step-by-step through configuration with an underlying focus on the defined role of an HMC as either a primary, replica, or peer.

– *Remote Code Load (RCL) enhancements*

IBM z15 introduced the RCL option for IBM Z firmware, enabling IBM to upgrade the IBM Z system remotely through an IBM Z Remote Support Facility (zRSF) using only the outbound connection from the HMC. Clients can choose what and when to be updated, and IBM monitors the entire process remotely and notifies the client upon completion.

IBM z16 has incorporated feedback from that IBM z15 experience, and the following IBM z16 enhancements are included:

HMC 2.16.0 provides the capability for an HMC to do data replication of the RCL authorization token, allowing it to be used on any HMC in the enterprise.

IBM Resource Link(R) provides the capability to reschedule an RCL, such as changing the time or date of the load or the bundle level, without requiring the client to do an HMC RCL Cancel.

IBM HMC Mobile provides the ability to generate the HMC authorization and view and cancel scheduled updates.

The ability to do a single HMA HMC Remote Code schedule, which ensures both HMCs on the HMAs are updated, including the required action of primary/alternate switch.

- **IBM HMC Mobile enhancements:**

  HMC Mobile 4.0 provides enhanced logon support for the new HMC 2.16.0 Multi-Factor Authentication types of Generic RADIUS and certificates as well as support for PCI-DSS compliance.

  HMC Mobile 4.0 additionally provides support for RCL HMC authorization token generation as well as the ability to view and cancel scheduled updates.

- **HMC YouTube videos:**

  General documentation on the HMC can be found on HMC Online Help and on IBM Resource Link.

  There is additional information on HMC through YouTube videos, which include subject areas like HMC Overview and Management, Access and Security, HMC Mobile, Manage System Time, and Dynamic Partition Manager.

  Current videos are available on https://ibm.biz/IBM-Z-HMC. This website should also be monitored for videos being added to the IBM HMC playlist, which will include some of the new HMC 2.16.0 features and enhancements.

For HMC 2.16.0, there will no longer be support to configure NTP with Autokey because Autokey is known to not be secure.

On HMCs prior to 2.16.0, access to NTP used to have MD5 as the only supported hashing algorithm. MD5 is no longer secure, official support for MD5 has been withdrawn, and its use is discouraged. For HMC 2.16.0, SHA-512 will be the default hashing algorithm to be selected for new defines. MD5 will be allowed because both the server and client must match, and this change needs to be communicated with external NTP server owners.

Enhancements to software pricing Technology Transition Offerings (TTOs)

Complementing the announcement of the IBM z16 server, IBM is introducing:

- A new TTO called Technology Update Pricing for IBM z16
- New and revised Transition Charges for Sysplexes or Multiplexes TTOs for actively coupled Parallel Sysplexes (z/OS), loosely coupled complexes (z/TPF), and multiplexes (z/OS and z/TPF)
- IBM z16 server eligibility for Tailored Fit Pricing for IBM Z offerings

Technology Update Pricing for IBM z16 extends the software price and performance provided by Advanced Workload License Charges (AWLC) and Country Multiplex License Charges (CMLC) for IBM z16 servers. The new and revised Transition Charges for Sysplexes or Multiplexes offerings provide a transition to Technology Update Pricing for IBM z16 for clients who have not yet fully migrated to IBM z16 servers. This ensures that aggregation benefits are maintained and also phases in the benefits of Technology Update Pricing for IBM z16 pricing as clients migrate.

When an IBM z16 server is in an actively coupled Parallel Sysplex or a loosely coupled complex, you may choose either aggregated AWLC pricing or aggregated

Parallel Sysplex License Charges (PSLC) pricing, subject to all applicable terms and conditions.

When an IBM z16 server is part of a multiplex under Country Multiplex Pricing (CMP) terms, CMLC, Multiplex zNALC (MzNALC), and Flat Workload License Charges (FWLC) are the only pricing metrics available, subject to all applicable terms and conditions.

For additional information about software pricing for the IBM z16 server, see Software Announcement AP22-0100, dated April 05, 2022.

When an IBM z16 server is running z/VSE^(R), you may choose Midrange Workload License Charges (MWLC), subject to all applicable terms and conditions.

For more information about AWLC, CMLC, Tailored Fit Pricing for IBM Z, MzNALC, PSLC, MWLC, or the Technology Update Pricing and Transition Charges for Sysplexes or Multiplexes TTO offerings, see the IBM Z software pricing website.

The CMP offering was withdrawn as of January 1, 2021, as announced in U.S. Software Announcement AP20-0485, dated December 15, 2020. For existing CMP clients, machines currently eligible to be included in an existing multiplex cannot be older than two generations prior to the most recently available server. The most recent server at any given point in time will be considered generation N, and the prior two generations as N-1 and N-2, respectively.

Tailored Fit Pricing for IBM Z- Hardware Consumption Solution

Previously announced on May 4, 2021 in US announce letter. Tailored Fit Pricing for IBM Z-- Hardware Consumption Solution now adds Linux on IBM Z capability. This provides an always on, consumption-based Linux capacity corridor that provides hybrid cloud flexibility and control for unpredictable workload spikes throughout the day.

To be eligible for the new Tailored Fit Pricing for IBM Z- Hardware Consumption Solution for Linux, clients are required to be on IBM z15 or IBM z16 hardware.

Contact your IBM Z Hardware Representative to determine if you qualify for this offering. If it is determined that Tailored Fit Pricing for IBM Z- Hardware Consumption Solution for Linux may be an appropriate solution for a client's unpredictable daily workload, the subscription and maintenance fee will be based upon the size of the clients' variable capacity corridor. The fee for measured usage will be charged if the workload spikes into the corridor. Clients that are outsourcing service providers are not eligible for the Tailored Fit Pricing for IBM Z Hardware Consumption Solution offering.

BTA water

BTA water is available to those clients who want to relocate their IBM 3931. Removed BTA water must be disposed of properly by the client. BTA water is a mixture of deionized (DI) water and 900-990 PPM benzotriazole (BTA), a corrosion inhibitor.

- IBM machine type 2819 model BTA feature 9849 provides three 20-liter jugs and supports IBM z13^(R) and IBM z14.
- Feature 9850 provides one 20-liter jug and supports IBM z15 and IBM z16.
- IBM machine type 3931 with feature 4040 A Frame Radiator, needs one jug plus one spare jug.
- IBM machine type 3931 with feature 4041 B Frame Radiator, needs one jug plus one spare jug.

Statement of general direction

Removal of support for OSE CHPID type: IBM z16 will be the last IBM Z server to support OSE networking channels. IBM Z support for the Systems Network Architecture (SNA) protocol being transported natively out of the server using OSA-Express 1000BASE-T adapters configured as channel type OSE will be eliminated after IBM z16. Client applications that rely on the SNA protocol and use OSE networking channels as the transport, as opposed to FICON(R) CTC, must either migrate to TCP/IP, or the networking configuration of the operating system image must be updated to make use of some form of SNA over IP technology, where possible, such as z/OS Enterprise Extender.

Removal of support for OSA-Express 1000BASE-T hardware adapters: IBM z16 will be the last IBM Z server to support OSA-Express 1000BASE-T hardware adapters (#0426, #0446, and #0458). Definition of all valid OSA CHPID types will be allowed only on OSA-Express GbE adapters, and potentially higher bandwidth fiber Ethernet adapters, on future servers.

Transition to PCIe-based adapters like RoCE Express as the strategic adapter for Linux on IBM Z: In the future, IBM plans to shift from OSA-Express to PCIe-based networking devices like RoCE Express as the target strategic adapter type for IBM Z direct access networking connection to Linux operating systems. MES updates between generations are planned to be supported. Linux on IBM Z clients that indirectly access the OSA-Express adapter family through the z/VM Virtual Switch (VSwitch) will be unaffected by this change. Linux on IBM Z networking currently supports two Ethernet networking connectivity options: the OSA-Express adapter family and the RoCE Express adapter family. Use of PCIe-based networking devices as provided by the RoCE Express adapter family is aligned with the deployment model for Linux on other architectural platforms, facilitates use of broader existing Linux ecosystem tooling, and eases the effort to enable exploitation of industry hardware optimizations and integrate into industry software-defined networking models and tools, including Red Hat OpenShift Container Platform (OCP). Clients are strongly encouraged to plan accordingly for their adoption of RoCE Express adapters for IBM Z networking connectivity. IBM plans to continue to work toward common networking adapters for all operating systems on IBM Z, IBM LinuxONE, and Linux on IBM Z.

Capacity on Demand (CoD) legacy automation: IBM z16 is planned to be the last server family to support Legacy CoD unique record type automation interfaces. Clients should begin migrating to the new CoD flexible record structure interface. Prior to IBM z10, automation interfaces for CoD were unique for each record type. The IBM z10 server introduced new automation interfaces for CoD, which used flexible record structures that could apply to any CoD temporary record, and attributes of temporary capacity records are returned as an XML structure.

Firmware update process: IBM z16 is planned to be the last server family to support IBM service support representatives (SSRs) onsite performing firmware updates without an additional premium service contract. The IBM Z Remote Code Load (RCL) option, which was introduced on IBM z15, is available without an additional premium service contract. With IBM z15, and now IBM z16, clients can request a remote code load or they can choose the SSR onsite method for their firmware update. IBM recommends that clients try the RCL option on IBM z15 or IBM z16 to see for themselves that IBM provides the same quality service through RCL.

Removal of support of the transactional execution and constrained transactional execution facility: In a future IBM Z hardware system family, the transactional execution and constrained transactional execution facility will no longer be supported. Users of the facility on current servers should always check the facility indications before use.

Removal of support for Bulk Power Assembly (BPA): IBM z16 is planned to be the last generation of IBM Z server to support BPA.

z/OS Containers and Kubernetes orchestration support for IBM z/OS applications and workloads: IBM has previously announced the intention to provide clients with capabilities that will help accelerate their transformation to greater portability and agility in a hybrid cloud environment by delivering z/OS

Containers and Kubernetes orchestration support for IBM z/OS applications and workloads. To deliver on this capability, IBM intends to provide a beta program for z/OS 2.5 clients to begin their container journey with z/OS UNIX$^{(R)}$ applications. These capabilities are designed to support architecture-independent standards and new containerized deployment options. The intention is to empower agile development teams to incorporate z/OS applications into a Kubernetes-based orchestration model utilizing industry standard operations. Future z/OS container use cases are planned to promote application modernization, new application development, and API creation with tight integration to core z/OS applications.

IBM LinuxONE Next release: In addition to the Linux on IBM Z functionality described in this RFA, which will be available on IBM z16, IBM plans to announce and release a new generation of LinuxONE systems in the second half of 2022, designed to help enterprises in their hybrid cloud and AI journey.

Statements by IBM regarding its plans, directions, and intent are subject to change or withdrawal without notice at the sole discretion of IBM. Information regarding potential future products is intended to outline general product direction and 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 IBM products remain at the sole discretion of IBM.

Reference information

For more information on Technology Transition Offerings for IBM z16, see Software Announcement AP22-0100, dated April 05, 2022.

For more information on Preview: IBM Z/VM 7.3, see Software Announcement AP22-0099, dated April 05, 2022.

For more information on IBM z/OS Change Tracker, see Software Announcement AP22-0013, dated April 05, 2022.

For more information on IBM Db2$^{(R)}$ Tools for z/OS update, see Software Announcement AP22-0118, dated April 05, 2022.

For more information on IBM Db2 13 for z/OS Value Unit Edition, IBM Db2 AI for z/OS 1.5, and IBM Watson$^{(R)}$ Machine Learning 2.4, see Software Announcement AP22-0058, dated April 05, 2022.

For more information on IBM Z Platform for Apache Spark, see Software Announcement AP22-0043, dated April 05, 2022.

For more information on IBM z/OS V2.5 2022 1Q enhancements, see Software Announcement AP22-0079, dated March 15, 2022.

For more information on IBM zCX Foundation for Red Hat OpenShift, see Software Announcement AP22-0088, dated March 15, 2022.

For more information on IBM Cloud Infrastructure Center 1.1.5, see Software Announcement AP22-0116, dated March 01, 2022.

For more information on IBM Z and Cloud Modernization Stack 2022.1.1, see Software Announcement AP22-0060, dated January 18, 2022.

For more information on IBM z/OS 2.5 2021 4Q enhancements, see Software Announcement AP21-0381, dated November 23, 2021.

For more information on IBM z/OS 2.5 Availability, see Software Announcement AP21-0249, dated July 27, 2021.

For more information on IBM Container Hosting Foundation for z/OS, see Software Announcement AP21-0119, dated June 01, 2021.

For more information on IBM z15 Model T01 and T02 Enhancements 2021 2Q, see Hardware Announcement AG21-0028, dated May 04, 2021.

For more information on Preview: IBM Security(R) zSecure suite for z/OS, 2.5, see Software Announcement AP21-0106, dated March 09, 2021.

For more information on Z/VM 7.2, see Software Announcement AP20-0292, dated August 04, 2020.

For more information on IBM z15 Model T01 and T02 Enhancements, see Hardware Announcement AG20-0056, dated August 04, 2020.

For more information on IBM z15 Model T02, see Hardware Announcement AG20-0006, dated April 14, 2020.

For more information on IBM System Recovery Boost Multi year upgrade, see Hardware Announcement AG20-0031, dated April 14, 2020.

For more information on IBM Fibre Channel Endpoint Security for IBM z15 and LinuxONE, see Hardware Announcement AG20-0013, dated January 14, 2020.

For more information on the IBM z15 System Recovery Boost Feature code name change, see Hardware Announcement AG19-0094, dated November 26, 2019.

For more information on the IBM z15, see Hardware Announcement AG19-0032, dated September 12, 2019.

Product number

Description	Machine Type	Model	Feature Number
IBM z16™	3931	A01	
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
Exchange Pgm Machine			0012
Exchange Pgm Machine + Covers			0013
Migration Offering Machine			0014
Blue Letter Internal			0015
Non RSF On/Off CoD			0032
Serv Docs Optional Print			0033
OSA-ICC 3215 Enablement			0034
RFID Tag			0035
RFID Tag			0036
TKE Rack Mount			0057

Description	Machine Type	Model	Feature Number
TKE			0058
OEM Generic Indicator			0093
WWPN Persistence			0099
Secure Execution for Linux			0115
IBM Z HW Mgmt Appliance			0129
Fanout Airflow PCIe			0137
TKE Tower			0144
TKE Rack			0145
TKE Rack KMM			0156
ICS SR fanout			0172
PCIe+ fanout			0175
ICA SR1.1			0176
Client Must Provide TKE KMM			0190
3906 w/o TEIO & w/o HtR			0201
3906 w/TEIO & w/o HtR			0202
3906 w/o TEIO & w/HtR			0203
3906 w/TEIO & w/HtR			0204
TKE Rack			0233
TKE Tower			0234
DPM			0250
TFP Monthly Sub 1 MSU			0253
TFP Monthly Sub 100 MSU			0254
TFP Monthly Sub 10000 MSU			0255
Prepaid TFP Sub 1 MSU			0256
Prepaid TFP Sub 100 MSU			0257
Prepaid TFP Sub 10000 MSU			0258
TFP Subscription Months			0259
TFP Hourly 1 MSU			0260
TFP Hourly 100 MSU			0261
TFP Hourly 10000 MSU			0262
TFP Daily 1 MSU			0263
TFP Daily 100 MSU			0264
TFP Daily 10000 MSU			0265
Flexible Cap 1 Unit			0317
Flexible Cap 100 Units			0318
Flexible Cap 10000 Units			0319
Flexible Cap IFL			0320
Flexible Cap ICF			0321
Flexible Cap zIIP			0322

Description	Machine Type	Model	Feature Number
Flexible Capacity Record			0376
Flexible Cap Term Years			0377
Flexible Capacity 1 Unit Year			0378
Flexible Capacity 100 Units Year			0379
Flexible Capacity 10000Units Year			0380
Flexible Cap IFL Year			0381
Flexible Cap 100 IFL Year			0382
Flexible Cap ICF Year			0383
Flexible Cap 100 ICF Year			0384
Flexible Cap zIIP Year			0385
Flexible Cap 100 zIIP Year			0386
Returning MT Digit 1			0389
Returning MT Digit 2			0390
Returning MT Digit 3			0391
Returning MT Digit 4			0392
Plant of MFG Digit 1			0393
Plant of MFG Digit 2			0394
Serial Number Digit 1			0395
Serial Number Digit 2			0396
Serial Number Digit 3			0397
Serial Number Digit 4			0398
Serial Number Digit 5			0399
PCIe Interconnect(R) Gen4			0421
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
Coupling Express2 LR			0434

Description	Machine Type	Model	Feature Number
10GbE RoCE Express3 SR			0440
10GbE RoCE Express3 LR			0441
zHyperLink Express1.1			0451
25GbE RoCE Express3 SR			0452
25GbE RoCE Express3 LR			0453
OSA-Express7S GbE LX 1.2			0454
OSA-Express7S GbE SX 1.2			0455
OSA-Express7S 10 GbE LR 1.2			0456
OSA-Express7S 10 GbE SR 1.2			0457
OSA-Express7S 1000BASE-T 1.2			0458
OSA-Express7S 25 GbE SR 1.2			0459
OSA-Express7S 25 GbE LR 1.2			0460
FICON Express32S LX			0461
FICON Express32S SX			0462
Model A01			0508
8561 RCU A Frame w/o Ht Red			0546
8561 RCU B Frame w/o Ht Red			0547
8561 RCU C Frame w/o Ht Red			0548
8561 RCU Z Frame w/o Ht Red			0549
8561 RCU A Frame w/ Ht Red			0550
8561 RCU B Frame w/ Ht Red			0551
8561 RCU C Frame w/ Ht Red			0552
8561 RCU Z Frame w/ Ht Red			0553
8561 WCU A Frame w/o Ht Red			0554
8561 WCU B Frame w/o Ht Red			0555
8561 WCU C Frame w/o Ht Red			0556
8561 WCU Z Frame w/o Ht Red			0557
8561 WCU A Frame w/ Ht Red			0558
8561 WCU B Frame w/ Ht Red			0559
8561 WCU C Frame w/ Ht Red			0560
8561 WCU Z Frame w/ Ht Red			0561
CPC PSU			0642

Description	Machine Type	Model	Feature Number
IBM Virtual Flash Memory			0644
Ethernet Switch			0647
Bulk Power Assembly			0648
Max39			0667
Max82			0668
Max125			0669
Max168			0670
Max200			0671
32GB USB Load Media			0843
No Physical Media			0846
32GB USB Backup Media			0848
4770 Crypto Adapter			0851
TKE 10.0 LIC			0882
TKE Smart Card Reader			0891
TKE addl smart cards			0900
Crypto Express8S (2 HSM)			0908
Crypto Express8S (1 HSM)			0909
US TAA Compliance Indicator			0983
STP Enablement			1021
EMEA Special Operations			1022
VFM/Flash Converted, 1to1			1121
VFM/Flash Converted, 1to2			1122
VFM/Flash Converted, 1to3			1123
Endpoint Security Enablement			1146
32 GB Mem DIMM (8/feat)			1746
64 GB Mem DIMM (8/feat)			1747
128 GB Mem DIMM (8/feat)			1748
256 GB Mem DIMM (8/feat)			1749
LICCC Ship Via Net Ind			1750
CP4			1955
CP5			1956
CP6			1957
CP7			1958
IFL			1959
ICF			1960
zIIP			1961
Unassigned IFL			1962
SAP (optional)			1963
32GB Flex Memory			1964

Description	Machine Type	Model	Feature Number
64GB Flex Memory			1965
256GB Flex Memory			1966
64GB VFM Flex Memory			1967
32GB Memory Cap Incr			1968
64GB Memory Cap Incr			1969
256GB Memory Cap Incr			1970
32GB Converted Mem			1971
64GB Converted Mem			1972
256GB Converted Mem			1973
Unassigned ICF			1974
Unassigned zIIP			1975
512 GB Memory			2825
576 GB Memory			2826
640 GB Memory			2827
704 GB Memory			2828
768 GB Memory			2829
896 GB Memory			2830
1024 GB Memory			2831
1152 GB Memory			2832
1280 GB Memory			2833
1408 GB Memory			2834
1536 GB Memory			2835
1664 GB Memory			2836
1792 GB Memory			2837
1920 GB Memory			2838
2048 GB Memory			2839
2304 GB Memory			2840
2560 GB Memory			2841
2816 GB Memory			2842
3072 GB Memory			2843
3328 GB Memory			2844
3584 GB Memory			2845
3840 GB Memory			2846
4352 GB Memory			2847
4864 GB Memory			2848
5376 GB Memory			2849
5888 GB Memory			2850
6400 GB Memory			2851
6912 GB Memory			2852
7424 GB Memory			2853
7936 GB Memory			2854
8448 GB Memory			2855
8960 GB Memory			2856
9472 GB Memory			2857
9984 GB Memory			2858
10496GB Memory			2859
11008 GB Memory			2860
11520 GB Memory			2861
12032 GB Memory			2862

Description	Machine Type	Model	Feature Number
12544 GB Memory			2863
13056 GB Memory			2864
13568 GB Memory			2865
14080 GB Memory			2866
14592 GB Memory			2867
15104 GB Memory			2868
15616 GB Memory			2869
16128 GB Memory			2870
16640 GB Memory			2871
17152 GB Memory			2872
18176 GB Memory			2873
19200 GB Memory			2874
20224 GB Memory			2875
21248 GB Memory			2876
22272 GB Memory			2877
23296 GB Memory			2878
24320 GB Memory			2879
25344 GB Memory			2880
26368 GB Memory			2881
27392 GB Memory			2882
28416 GB Memory			2883
29440 GB Memory			2884
30464 GB Memory			2885
31488 GB Memory			2886
32512 GB Memory			2887
34560 GB Memory			2888
36608 GB Memory			2889
38656 GB Memory			2890
40704 GB Memory			2891
CPC1 Reserve			2981
CPC2 Reserve			2982
Balanced Power Plan Ahead			3003
BPR Pair			3017
Lift Tool Kit			3100
Extension Ladder			3101
Fill and Drain Kit			3393
CPACF Enablement			3863
PCIe+ I/O Drawer			4023
A Frame Radiator			4040
B Frame Radiator			4041
B Frame No Cooling			4042
Z Frame			4043
C Frame			4044
701 Capacity Marker			5144
702 Capacity Marker			5145
703 Capacity Marker			5146
704 Capacity Marker			5147
705 Capacity Marker			5148
706 Capacity Marker			5149

Description	Machine Type	Model	Feature Number
707 Capacity Marker			5150
708 Capacity Marker			5151
709 Capacity Marker			5152
710 Capacity Marker			5153
711 Capacity Marker			5154
712 Capacity Marker			5155
713 Capacity Marker			5156
714 Capacity Marker			5157
715 Capacity Marker			5158
716 Capacity Marker			5159
717 Capacity Marker			5160
718 Capacity Marker			5161
719 Capacity Marker			5162
720 Capacity Marker			5163
721 Capacity Marker			5164
722 Capacity Marker			5165
723 Capacity Marker			5166
724 Capacity Marker			5167
725 Capacity Marker			5168
726 Capacity Marker			5169
727 Capacity Marker			5170
728 Capacity Marker			5171
729 Capacity Marker			5172
730 Capacity Marker			5173
731 Capacity Marker			5174
732 Capacity Marker			5175
733 Capacity Marker			5176
734 Capacity Marker			5177
735 Capacity Marker			5178
736 Capacity Marker			5179
737 Capacity Marker			5180

Description	Machine Type	Model	Feature Number
738 Capacity Marker			5181
739 Capacity Marker			5182
740 Capacity Marker			5183
741 Capacity Marker			5184
742 Capacity Marker			5185
743 Capacity Marker			5186
744 Capacity Marker			5187
745 Capacity Marker			5188
746 Capacity Marker			5189
747 Capacity Marker			5190
748 Capacity Marker			5191
749 Capacity Marker			5192
750 Capacity Marker			5193
751 Capacity Marker			5194
752 Capacity Marker			5195
753 Capacity Marker			5196
754 Capacity Marker			5197
755 Capacity Marker			5198
756 Capacity Marker			5199
757 Capacity Marker			5200
758 Capacity Marker			5201
759 Capacity Marker			5202
760 Capacity Marker			5203
761 Capacity Marker			5204
762 Capacity Marker			5205
763 Capacity Marker			5206
764 Capacity Marker			5207
765 Capacity Marker			5208
766 Capacity Marker			5209
767 Capacity Marker			5210
768 Capacity Marker			5211

Description	Machine Type	Model	Feature Number
769 Capacity Marker			5212
770 Capacity Marker			5213
771 Capacity Marker			5214
772 Capacity Marker			5215
773 Capacity Marker			5216
774 Capacity Marker			5217
775 Capacity Marker			5218
776 Capacity Marker			5219
777 Capacity Marker			5220
778 Capacity Marker			5221
779 Capacity Marker			5222
780 Capacity Marker			5223
781 Capacity Marker			5224
782 Capacity Marker			5225
783 Capacity Marker			5226
784 Capacity Marker			5227
785 Capacity Marker			5228
786 Capacity Marker			5229
787 Capacity Marker			5230
788 Capacity Marker			5231
789 Capacity Marker			5232
790 Capacity Marker			5233
791 Capacity Marker			5234
792 Capacity Marker			5235
793 Capacity Marker			5236
794 Capacity Marker			5237
795 Capacity Marker			5238
796 Capacity Marker			5239
797 Capacity Marker			5240
798 Capacity Marker			5241
799 Capacity Marker			5242

Description	Machine Type	Model	Feature Number
7A0 Capacity Marker			5243
7A1 Capacity Marker			5244
7A2 Capacity Marker			5245
7A3 Capacity Marker			5246
7A4 Capacity Marker			5247
7A5 Capacity Marker			5248
7A6 Capacity Marker			5249
7A7 Capacity Marker			5250
7A8 Capacity Marker			5251
7A9 Capacity Marker			5252
7B0 Capacity Marker			5253
7B1 Capacity Marker			5254
7B2 Capacity Marker			5255
7B3 Capacity Marker			5256
7B4 Capacity Marker			5257
7B5 Capacity Marker			5258
7B6 Capacity Marker			5259
7B7 Capacity Marker			5260
7B8 Capacity Marker			5261
7B9 Capacity Marker			5262
7C0 Capacity Marker			5263
7C1 Capacity Marker			5264
7C2 Capacity Marker			5265
7C3 Capacity Marker			5266
7C4 Capacity Marker			5267
7C5 Capacity Marker			5268
7C6 Capacity Marker			5269
7C7 Capacity Marker			5270
7C8 Capacity Marker			5271
7C9 Capacity Marker			5272
7D0 Capacity Marker			5273

Description	Machine Type	Model	Feature Number
7D1 Capacity Marker			5274
7D2 Capacity Marker			5275
7D3 Capacity Marker			5276
7D4 Capacity Marker			5277
7D5 Capacity Marker			5278
7D6 Capacity Marker			5279
7D7 Capacity Marker			5280
7D8 Capacity Marker			5281
7D9 Capacity Marker			5282
7E0 Capacity Marker			5283
7E1 Capacity Marker			5284
7E2 Capacity Marker			5285
7E3 Capacity Marker			5286
7E4 Capacity Marker			5287
7E5 Capacity Marker			5288
7E6 Capacity Marker			5289
7E7 Capacity Marker			5290
7E8 Capacity Marker			5291
7E9 Capacity Marker			5292
7F0 Capacity Marker			5293
7F1 Capacity Marker			5294
7F2 Capacity Marker			5295
7F3 Capacity Marker			5296
7F4 Capacity Marker			5297
7F5 Capacity Marker			5298
7F6 Capacity Marker			5299
7F7 Capacity Marker			5300
7F8 Capacity Marker			5301
7F9 Capacity Marker			5302
7G0 Capacity Marker			5303
7G1 Capacity Marker			5304

Description	Machine Type	Model	Feature Number
7G2 Capacity Marker			5305
7G3 Capacity Marker			5306
7G4 Capacity Marker			5307
7G5 Capacity Marker			5308
7G6 Capacity Marker			5309
7G7 Capacity Marker			5310
7G8 Capacity Marker			5311
7G9 Capacity Marker			5312
7H0 Capacity Marker			5313
7H1 Capacity Marker			5314
7H2 Capacity Marker			5315
7H3 Capacity Marker			5316
7H4 Capacity Marker			5317
7H5 Capacity Marker			5318
7H6 Capacity Marker			5319
7H7 Capacity Marker			5320
7H8 Capacity Marker			5321
7H9 Capacity Marker			5322
7i0 Capacity Marker			5323
7i1 Capacity Marker			5324
7i2 Capacity Marker			5325
7i3 Capacity Marker			5326
7i4 Capacity Marker			5327
7i5 Capacity Marker			5328
7i6 Capacity Marker			5329
7i7 Capacity Marker			5330
7i8 Capacity Marker			5331
7i9 Capacity Marker			5332
7J0 Capacity Marker			5333
7J1 Capacity Marker			5334
7J2 Capacity Marker			5335

Description	Machine Type	Model	Feature Number
7J3 Capacity Marker			5336
7J4 Capacity Marker			5337
7J5 Capacity Marker			5338
7J6 Capacity Marker			5339
7J7 Capacity Marker			5340
7J8 Capacity Marker			5341
7J9 Capacity Marker			5342
7K0 Capacity Marker			5343
601 Capacity Marker			5344
602 Capacity Marker			5345
603 Capacity Marker			5346
604 Capacity Marker			5347
605 Capacity Marker			5348
606 Capacity Marker			5349
607 Capacity Marker			5350
608 Capacity Marker			5351
609 Capacity Marker			5352
610 Capacity Marker			5353
611 Capacity Marker			5354
612 Capacity Marker			5355
613 Capacity Marker			5356
614 Capacity Marker			5357
615 Capacity Marker			5358
616 Capacity Marker			5359
617 Capacity Marker			5360
618 Capacity Marker			5361
619 Capacity Marker			5362
620 Capacity Marker			5363
621 Capacity Marker			5364
622 Capacity Marker			5365
623 Capacity Marker			5366

Description	Machine Type	Model	Feature Number
624 Capacity Marker			5367
625 Capacity Marker			5368
626 Capacity Marker			5369
627 Capacity Marker			5370
628 Capacity Marker			5371
629 Capacity Marker			5372
630 Capacity Marker			5373
631 Capacity Marker			5374
632 Capacity Marker			5375
633 Capacity Marker			5376
634 Capacity Marker			5377
635 Capacity Marker			5378
636 Capacity Marker			5379
637 Capacity Marker			5380
638 Capacity Marker			5381
639 Capacity Marker			5382
400 Capacity Marker			5409
401 Capacity Marker			5410
402 Capacity Marker			5411
403 Capacity Marker			5412
404 Capacity Marker			5413
405 Capacity Marker			5414
406 Capacity Marker			5415
407 Capacity Marker			5416
408 Capacity Marker			5417
409 Capacity Marker			5418
410 Capacity Marker			5419
411 Capacity Marker			5420
412 Capacity Marker			5421
413 Capacity Marker			5422
414 Capacity Marker			5423

Description	Machine Type	Model	Feature Number
415 Capacity Marker			5424
416 Capacity Marker			5425
417 Capacity Marker			5426
418 Capacity Marker			5427
419 Capacity Marker			5428
420 Capacity Marker			5429
421 Capacity Marker			5430
422 Capacity Marker			5431
423 Capacity Marker			5432
424 Capacity Marker			5433
425 Capacity Marker			5434
426 Capacity Marker			5435
427 Capacity Marker			5436
428 Capacity Marker			5437
429 Capacity Marker			5438
430 Capacity Marker			5439
431 Capacity Marker			5440
432 Capacity Marker			5441
433 Capacity Marker			5442
434 Capacity Marker			5443
435 Capacity Marker			5444
436 Capacity Marker			5445
437 Capacity Marker			5446
438 Capacity Marker			5447
439 Capacity Marker			5448
501 Capacity Marker			5449
502 Capacity Marker			5450
503 Capacity Marker			5451
504 Capacity Marker			5452
505 Capacity Marker			5453
506 Capacity Marker			5454

Description	Machine Type	Model	Feature Number
507 Capacity Marker			5455
508 Capacity Marker			5456
509 Capacity Marker			5457
510 Capacity Marker			5458
511 Capacity Marker			5459
512 Capacity Marker			5460
513 Capacity Marker			5461
514 Capacity Marker			5462
515 Capacity Marker			5463
516 Capacity Marker			5464
517 Capacity Marker			5465
518 Capacity Marker			5466
519 Capacity Marker			5467
520 Capacity Marker			5468
521 Capacity Marker			5469
522 Capacity Marker			5470
523 Capacity Marker			5471
524 Capacity Marker			5472
525 Capacity Marker			5473
526 Capacity Marker			5474
527 Capacity Marker			5475
528 Capacity Marker			5476
529 Capacity Marker			5477
530 Capacity Marker			5478
531 Capacity Marker			5479
532 Capacity Marker			5480
533 Capacity Marker			5481
534 Capacity Marker			5482
535 Capacity Marker			5483
536 Capacity Marker			5484
537 Capacity Marker			5485

Description	Machine Type	Model	Feature Number
538 Capacity Marker			5486
539 Capacity Marker			5487
FQC Bracket & Mounting Hdw			5827
Total SRB Months Ordered			6798
Total SRB Years Ordered			6799
Sys Recovery Boost Record			6802

Description	Machine Type	Model	Feature Number
Additional CBU Test			6805
Total CBU Years Ordered			6817
CBU Records Ordered			6818
Single CBU CP Year			6820
25 CBU CP Year			6821
Single CBU IFL Year			6822
25 CBU IFL Year			6823
Single CBU ICF Year			6824
25 CBU ICF Year			6825
Single CBU zIIP Year			6828
25 CBU zIIP Year			6829
Single CBU SAP Year			6830
25 CBU SAP Year			6831
CBU Replenishment			6832
OPO Sales Flag			6835
OPO Sales Flag-Alteration			6836
Top Exit Cabling w/o Tophat			7816
Flex Cap Perpetual License			7805
Flexible Cap Term License			7806
Top Exit Cabling w/Top Hat			7898
Bottom Exit Cabling			7899
Non Raised Floor Support			7998
19in Earthquake Kit, RF			8014
19in Earthquake Kit, NRF			8015

Description	Machine Type	Model	Feature Number
Zero-Way Processor CP4			8023
1-Way Processor CP4			8024
2-Way Processor CP4			8025
3-Way Processor CP4			8026
4-Way Processor CP4			8027
5-Way Processor CP4			8028
6-Way Processor CP4			8029
7-Way Processor CP4			8030
8-Way Processor CP4			8031
9-Way Processor CP4			8032
10-Way Processor CP4			8033
11-Way Processor CP4			8034
12-Way Processor CP4			8035
13-Way Processor CP4			8036
14-Way Processor CP4			8037
15-Way Processor CP4			8038
16-Way Processor CP4			8039
17-Way Processor CP4			8040
18-Way Processor CP4			8041
19-Way Processor CP4			8042
20-Way Processor CP4			8043
21-Way Processor CP4			8044
22-Way Processor CP4			8045
23-Way Processor CP4			8046
24-Way Processor CP4			8047
25-Way Processor CP4			8048
26-Way Processor CP4			8049
27-Way Processor CP4			8050
28-Way Processor CP4			8051
29-Way Processor CP4			8052
30-Way Processor CP4			8053

Description	Machine Type	Model	Feature Number
31-Way Processor CP4			8054
32-Way Processor CP4			8055
33-Way Processor CP4			8056
34-Way Processor CP4			8057
35-Way Processor CP4			8058
36-Way Processor CP4			8059
37-Way Processor CP4			8060
38-Way Processor CP4			8061
39-Way Processor CP4			8062
1-Way Processor CP5			8332
2-Way Processor CP5			8333
3-Way Processor CP5			8334
4-Way Processor CP5			8335
5-Way Processor CP5			8336
6-Way Processor CP5			8337
7-Way Processor CP5			8338
8-Way Processor CP5			8339
9-Way Processor CP5			8340
10-Way Processor CP5			8341
11-Way Processor CP5			8342
12-Way Processor CP5			8343
13-Way Processor CP5			8344
14-Way Processor CP5			8345
15-Way Processor CP5			8346
16-Way Processor CP5			8347
17-Way Processor CP5			8348
18-Way Processor CP5			8349
19-Way Processor CP5			8350
20-Way Processor CP5			8351
21-Way Processor CP5			8352
22-Way Processor CP5			8353

Description	Machine Type	Model	Feature Number
23-Way Processor CP5			8354
24-Way Processor CP5			8355
25-Way Processor CP5			8356
26-Way Processor CP5			8357
27-Way Processor CP5			8358
28-Way Processor CP5			8359
29-Way Processor CP5			8360
30-Way Processor CP5			8361
31-Way Processor CP5			8362
32-Way Processor CP5			8363
33-Way Processor CP5			8364
34-Way Processor CP5			8365
35-Way Processor CP5			8366
36-Way Processor CP5			8367
37-Way Processor CP5			8368
38-Way Processor CP5			8369
39-Way Processor CP5			8370
1-Way Processor CP6			8371
2-Way Processor CP6			8372
3-Way Processor CP6			8373
4-Way Processor CP6			8374
5-Way Processor CP6			8375
6-Way Processor CP6			8376
7-Way Processor CP6			8377
8-Way Processor CP6			8378
9-Way Processor CP6			8379
10-Way Processor CP6			8380
11-Way Processor CP6			8381
12-Way Processor CP6			8382
13-Way Processor CP6			8383
14-Way Processor CP6			8384

Description	Machine Type	Model	Feature Number
15-Way Processor CP6			8385
16-Way Processor CP6			8386
17-Way Processor CP6			8387
18-Way Processor CP6			8388
19-Way Processor CP6			8389
20-Way Processor CP6			8390
21-Way Processor CP6			8391
22-Way Processor CP6			8392
23-Way Processor CP6			8393
24-Way Processor CP6			8394
25-Way Processor CP6			8395
26-Way Processor CP6			8396
27-Way Processor CP6			8397
28-Way Processor CP6			8398
29-Way Processor CP6			8399
30-Way Processor CP6			8400
31-Way Processor CP6			8401
32-Way Processor CP6			8402
33-Way Processor CP6			8403
34-Way Processor CP6			8404
35-Way Processor CP6			8405
36-Way Processor CP6			8406
37-Way Processor CP6			8407
38-Way Processor CP6			8408
39-Way Processor CP6			8409
1-Way Processor CP7			8410
2-Way Processor CP7			8411
3-Way Processor CP7			8412
4-Way Processor CP7			8413
5-Way Processor CP7			8414
6-Way Processor CP7			8415

Description	Machine Type	Model	Feature Number
7-Way Processor CP7			8416
8-Way Processor CP7			8417
9-Way Processor CP7			8418
10-Way Processor CP7			8419
11-Way Processor CP7			8420
12-Way Processor CP7			8421
13-Way Processor CP7			8422
14-Way Processor CP7			8423
15-Way Processor CP7			8424
16-Way Processor CP7			8425
17-Way Processor CP7			8426
18-Way Processor CP7			8427
19-Way Processor CP7			8428
20-Way Processor CP7			8429
21-Way Processor CP7			8430
22-Way Processor CP7			8431
23-Way Processor CP7			8432
24-Way Processor CP7			8433
25-Way Processor CP7			8434
26-Way Processor CP7			8435
27-Way Processor CP7			8436
28-Way Processor CP7			8437
29-Way Processor CP7			8438
30-Way Processor CP7			8439
31-Way Processor CP7			8440
32-Way Processor CP7			8441
33-Way Processor CP7			8442
34-Way Processor CP7			8443
35-Way Processor CP7			8444
36-Way Processor CP7			8445
37-Way Processor CP7			8446

Description	Machine Type	Model	Feature Number
38-Way Processor CP7			8447
39-Way Processor CP7			8448
40-Way Processor CP7			8449
41-Way Processor CP7			8450
42-Way Processor CP7			8451
43-Way Processor CP7			8452
44-Way Processor CP7			8453
45-Way Processor CP7			8454
46-Way Processor CP7			8455
47-Way Processor CP7			8456
48-Way Processor CP7			8457
49-Way Processor CP7			8458
50-Way Processor CP7			8459
51-Way Processor CP7			8460
52-Way Processor CP7			8461
53-Way Processor CP7			8462
54-Way Processor CP7			8463
55-Way Processor CP7			8464
56-Way Processor CP7			8465
57-Way Processor CP7			8466
58-Way Processor CP7			8467
59-Way Processor CP7			8468
60-Way Processor CP7			8469
61-Way Processor CP7			8470
62-Way Processor CP7			8471
63-Way Processor CP7			8472
64-Way Processor CP7			8473
65-Way Processor CP7			8474
66-Way Processor CP7			8475
67-Way Processor CP7			8476
68-Way Processor CP7			8477

Description	Machine Type	Model	Feature Number
69-Way Processor CP7			8478
70-Way Processor CP7			8479
71-Way Processor CP7			8480
72-Way Processor CP7			8481
73-Way Processor CP7			8482
74-Way Processor CP7			8483
75-Way Processor CP7			8484
76-Way Processor CP7			8485
77-Way Processor CP7			8486
78-Way Processor CP7			8487
79-Way Processor CP7			8488
80-Way Processor CP7			8489
81-Way Processor CP7			8490
82-Way Processor CP7			8491
83-Way Processor CP7			8492
84-Way Processor CP7			8493
85-Way Processor CP7			8494
86-Way Processor CP7			8495
87-Way Processor CP7			8496
88-Way Processor CP7			8497
89-Way Processor CP7			8498
90-Way Processor CP7			8499
91-Way Processor CP7			8500
92-Way Processor CP7			8501
93-Way Processor CP7			8502
94-Way Processor CP7			8503
95-Way Processor CP7			8504
96-Way Processor CP7			8505
97-Way Processor CP7			8506
98-Way Processor CP7			8507
99-Way Processor CP7			8508

Description	Machine Type	Model	Feature Number
100-Way Processor CP7			8509
101-Way Processor CP7			8510
102-Way Processor CP7			8511
103-Way Processor CP7			8512
104-Way Processor CP7			8513
105-Way Processor CP7			8514
106-Way Processor CP7			8515
107-Way Processor CP7			8516
108-Way Processor CP7			8517
109-Way Processor CP7			8518
110-Way Processor CP7			8519
111-Way Processor CP7			8520
112-Way Processor CP7			8521
113-Way Processor CP7			8522
114-Way Processor CP7			8523
115-Way Processor CP7			8524
116-Way Processor CP7			8525
117-Way Processor CP7			8526
118-Way Processor CP7			8527
119-Way Processor CP7			8528
120-Way Processor CP7			8529
121-Way Processor CP7			8530
122-Way Processor CP7			8531
123-Way Processor CP7			8532
124-Way Processor CP7			8533
125-Way Processor CP7			8534
126-Way Processor CP7			8535
127-Way Processor CP7			8536
128-Way Processor CP7			8537
129-Way Processor CP7			8538
130-Way Processor CP7			8539

Description	Machine Type	Model	Feature Number
131-Way Processor CP7			8540
132-Way Processor CP7			8541
133-Way Processor CP7			8542
134-Way Processor CP7			8543
135-Way Processor CP7			8544
136-Way Processor CP7			8545
137-Way Processor CP7			8546
138-Way Processor CP7			8547
139-Way Processor CP7			8548
140-Way Processor CP7			8549
141-Way Processor CP7			8550
142-Way Processor CP7			8551
143-Way Processor CP7			8552
144-Way Processor CP7			8553
145-Way Processor CP7			8554
146-Way Processor CP7			8555
147-Way Processor CP7			8556
148-Way Processor CP7			8557
149-Way Processor CP7			8558
150-Way Processor CP7			8559
151-Way Processor CP7			8560
152-Way Processor CP7			8561
153-Way Processor CP7			8562
154-Way Processor CP7			8563
155-Way Processor CP7			8564
156-Way Processor CP7			8565
157-Way Processor CP7			8566
158-Way Processor CP7			8567
159-Way Processor CP7			8568
160-Way Processor CP7			8569
161-Way Processor CP7			8570

Description	Machine Type	Model	Feature Number
162-Way Processor CP7			8571
163-Way Processor CP7			8572
164-Way Processor CP7			8573
165-Way Processor CP7			8574
166-Way Processor CP7			8575
167-Way Processor CP7			8576
168-Way Processor CP7			8577
169-Way Processor CP7			8578
170-Way Processor CP7			8579
171-Way Processor CP7			8580
172-Way Processor CP7			8581
173-Way Processor CP7			8582
174-Way Processor CP7			8583
175-Way Processor CP7			8584
176-Way Processor CP7			8585
177-Way Processor CP7			8586
178-Way Processor CP7			8587
179-Way Processor CP7			8588
180-Way Processor CP7			8589
181-Way Processor CP7			8590
182-Way Processor CP7			8591
183-Way Processor CP7			8592
184-Way Processor CP7			8593
185-Way Processor CP7			8594
186-Way Processor CP7			8595
187-Way Processor CP7			8596
188-Way Processor CP7			8597
189-Way Processor CP7			8598
190-Way Processor CP7			8599
191-Way Processor CP7			8600
192-Way Processor CP7			8601

Description	Machine Type	Model	Feature Number
193-Way Processor CP7			8602
194-Way Processor CP7			8603
195-Way Processor CP7			8604
196-Way Processor CP7			8605
197-Way Processor CP7			8606
198-Way Processor CP7			8607
199-Way Processor CP7			8608
200-Way Processor CP7			8609
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 Act 100 IFL Days			9874
On Off CoD Act 100 ICF Days			9875
On Off CoD Act 100 CP Days			9876
On Off CoD Act 100 zIIP Days			9877
On Off CoD Act 100 SAP Days			9878
On Off CoD Act IFL Days			9888
On Off CoD Act ICF Days			9889
On Off COD authorization			9896
On Off CoD Act Cap CP Days			9897
Perm upgr authorization			9898
CIU Activation (Flag)			9899
On Line CoD Buying (Flag)			9900
On Off CoD Act zIIP Days			9908
On Off CoD Act SAP Days			9909
CBU authorization			9910
OPO Sales authorization			9913
1 MSU day			9917
100 MSU days			9918
10000 MSU days			9919
1 IFL day			9920
100 IFL days			9921

Description	Machine Type	Model	Feature Number
1 ICF day			9922
100 ICF days			9923
1 zIIP day			9924
100 zIIP days			9925
1 SAP day			9928
100 SAP days			9929
Boost Authorization			9930
TFP for Z HW Authorization			9932
Flex Capacity Authorization			9933
Height Reduce Ship			9975
Height Reduce for Return			9976

Description	Machine Type	Model	Feature Number
TKE Table Top KMM			0157

Description	Machine Type	Model	Feature Number
FOR CHINA ONLY			
IBM- Regional Cores Number			0329
PRC Tokens			6803
PRC Tokens Alteration			6804
PRC 1 MSU day			6806
PRC 100 MSU days			6807
PRC 10000 MSU days			6808
PRC 1 IFL day			6809
PRC 100 IFL days			6810
PRC 1 ICF day			6811
PRC 100 ICF days			6812
PRC 1 zIIP day			6813
PRC 100 zIIP days			6814
PRC 1 SAP day			6815
PRC 100 SAP days			6816
PRC Tokens Authorization			9904
FOR CHINA ONLY			

Description	Machine Type	Model	Feature Number
200-280V 30/60A, 3 Ph PDU			0645

Description	Machine Type	Model	Feature Number
380-415V 32A, 3 Ph WYE PDU			0646

Description	Machine Type	Model	Feature Number
32A/380-415V 3Ph Wye			7947
32A/380-415V 3Ph Wye LSZH			7948
60A/250V w/Cut End			7955
32A/380-415V Cut End			7957
32A/380-415V Cut End LSZH			7958
60A/250V w/Cut End LSZH			7965
60A/250V 3Ph w/Cut End			7972
60A/250V w/Cut End LSZH			7973

Description	Machine Type	Model	Feature Number
IBM z15	8561	T01	
IBM z15	8562	T02	
TKE Rack Mount			0057
TKE			0058
TKE Tower			0144
TKE Rack			0145
TKE Rack KMM			0156
TKE Rack			0233
TKE Tower			0234
TKE 10.0 LIC			0882

Description	Machine Type	Model	Feature Number
IBM z15	8561	T01	
IBM z15	8562	T02	
TKE Table Top KMM			0157

Features that may carry forward on an upgrade:

The following features may be retained if they are installed at the time of an upgrade to the IBM z16™:

Description	Machine Type	Model	Feature Number
HMC			0062
HMC Rack Mount			0063
HMC			0082
HMC Rack Mount			0083
TKE Rack Mount			0085
TKE			0086
TKE Rack Mount			0087
TKE			0088
TKE Tower			0144
TKE Rack			0145
HMC Table Top KMM			0148
HMC Rack KMM			0154
TKE Rack KMM			0156

Description	Machine Type	Model	Feature Number
TKE Table Top KMM			0157
ICA SR fanout			0172
PCIe+ fanout			0175
ICA SR1.1			0176
TKE Rack			0233
TKE Tower			0234
10 GbE RoCE Express2			0412
PCIe Interconnect(R) Gen4			0421
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
25GbE RoCE Express2			0430
zHyperLink Express			0431
10 GbE RoCE Express2.1			0432
FICON Express16SA LX			0436
FICON Express16SA SX			0437
OSA-Express7S GbE LX			0442
OSA-Express7S GbE SX			0443
OSA-Express7S 10 GbE LR			0444
OSA-Express7S 10 GbE SR			0445
OSA-Express7S 1000BASE-T			0446
OSA-Express7S 25 GbE SR1.1			0449
25GbE RoCE Express2.1			0450
zHyperLink Express1.1			0451
TKE Smart Card Reader			0885
TKE Smart Card Reader			0891
TKE addl smart cards			0892
Crypto Express6S			0893
Crypto Express7S (2 Port)			0898

Description	Machine Type	Model	Feature Number
Crypto Express7S (1 Port)			0899
TKE addl smart cards			0900
Lift Tool Kit			3100
Extension Ladder			3101
Fill and Drain Kit			3393
Capacity for Planned Event			6833
30A/400V 3Ph Wye w/Hubbell			7946
32A/380-415V 3Ph Wye			7947
32A/380-415V 3Ph Wye LSZH			7948
60A/250V w/ Hubbell			7954
60A/250V w/Cut End			7955
30A/400V Hubbell			7956
32A/380-415V Cut End			7957
32A/380-415V Cut End LSZH			7958
30A/480V Hubbell			7959
60A/250V w/Cut End LSZH			7965

Model conversions

From Machine Type	From Model	To Machine Type	To Model	
3906	M01	3931	A01	(*)
3906	M02	3931	A01	(*)
3906	M03	3931	A01	(*)
3906	M04	3931	A01	(*)
3906	M05	3931	A01	(*)
8561	T01	3931	A01	(*)

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

Feature conversions

The feature conversion list for IBM z16™ Model A01 is now available in the Library section of Resource Link.

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

Parts removed as a result of a feature conversion become the property of IBM.

Publications

The following publications are available now in the "Library" section of Resource Link:

Title	Order number
3931 Installation Manual for Physical Planning (IMPP)	GC28-7015

Title	Order number
PR/SM Planning Guide	SB10-7178
IOCP User's Guide for ICP IOCP	SB10-7177
Planning for Fiber Optic Links (FICON/ FCP, Coupling Links, OSA, and zHyperLink Express)	GA23-1409

The following publication is shipped with the product:

Title	Order number
3931 Installation Manual	GC28-7017

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
3931 Safety Inspection	GC28-7014
Service Guide for TKE Workstations (Version 7.0)	GC28-7020
Systems Safety Notices	G229-9054
IBM Important Notices	G229-9056
Statement of Limited Warranty Part 3 - Warranty Information	GC28-7013
License Agreement for Machine Code	SC28-6872
License Agreement for Machine Code Addendum for Cryptography	GC27-2635
Systems Environmental Notices and User Guide	Z125-5823

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

Title	Order number
3931 Service Guide	GC28-7018
3931 Parts Catalog	GC28-7019
Service Guide for 2461 Hardware Management Console	GC28-7021
Service Guide for 2461 Support Element	GC28-7022
SNMP Application Programming Interfaces	SB10-7179
Capacity on Demand User's Guide	SC28-7025
CHPID Mapping Tool User's Guide	GC28-7024
Hardware Management Console Web Services API (V2.16.0)	SC27-2642
IBM Dynamic Partition Manager (DPM) Guide	SB10-7182
Secure Service Container User's Guide	SC28-7028
Stand-Alone IOCP User's Guide	SB10-7180
FICON CTC Reference	SB10-7181
Maintenance Information for Fiber Optics (FICON/FCP, Coupling Links, OSA, and zHyperLink Express)	SY27-7697
Integrating the HMC's Broadband RSF into your Enterprise	SC28-7026
Hardware Management Console Security	SC28-7027
Remote Code Load for IBM Z Firmware	SC28-7044
SCSI IPL -- Machine Loader Messages	SC28-7029
OSA-Express Customer's Guide and Reference	SA22-7935
OSA/SF on the Hardware Management Console	SC14-7580
OSA Integrated Console Controller User's Guide	SC27-9003

Resource Link

Publications for IBM Z can be obtained at Resource Link .

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 2.16.0) will be available from IBM Resource Link and the consoles.

You can also find HMC videos at IBM Z Hardware Management Console Videos.

IBM Documentation

IBM Documentation provides a modernized user experience and makes it easier to find IBM product information for systems hardware, operating systems, and server software. Through a consistent framework, you can efficiently find information and personalize your access. The IBM Z publications are referenced at IBM Documentation.

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

Title	Order number
IBM z16 Technical Introduction	SG24-8950-00
IBM z16 Technical Guide	SG24-8951-00
IBM z16 Configuration Setup	SG24-8960-00
IBM z16 Connectivity Handbook	SG24-5444-21
IBM Z Functional Matrix	REDP-5157-06

To download these Redbooks publications, go to the IBM Z Redbooks website.

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

To access the IBM Publications Center Portal, go to the IBM Publications Center website.

The Publications Center is a worldwide central repository for IBM product publications and marketing material with a catalog of 70,000 items. Extensive search facilities are provided. A large number of publications are available online in various file formats, which can currently be downloaded.

National language support

Not applicable

Services

IBM Systems Lab Services

Systems Lab Services offers infrastructure services to help build hybrid cloud and enterprise IT solutions. From servers to storage systems and software, Systems Lab Services can help deploy the building blocks of a next-generation IT infrastructure to empower a client's business. Systems Lab Services consultants can perform infrastructure services for clients online or onsite, offering deep technical expertise, valuable tools, and successful methodologies. Systems Lab Services is designed to help clients solve business challenges, gain new skills, and apply best practices.

Systems Lab Services offers a wide range of infrastructure services for IBM Power servers, IBM Storage systems, IBM Z, IBM LinuxONE and Linux on IBM Z. Systems Lab Services has a global presence and can deploy experienced consultants online or onsite around the world.

For assistance, contact Systems Lab Services at ibmsls@us.ibm.com.

To learn more, see the IBM Systems Lab Services website.

IBM Consulting

As transformation continues across every industry, businesses need a single partner to map their enterprise-wide business strategy and technology infrastructure. IBM Consulting is the business partner to help accelerate change across an organization. IBM specialists can help businesses succeed through finding collaborative ways of working that forge connections across people, technologies, and partner ecosystems. IBM Consulting brings together the business expertise and an ecosystem of technologies that help solve some of the biggest problems faced by organizations. With methods that get results faster, an integrated approach that is grounded in an open and flexible hybrid cloud architecture, and incorporating technology from IBM Research$^{(R)}$ and IBM Watson AI, IBM Consulting enables businesses to lead change with confidence and deliver continuous improvement across a business and its bottom line.

For additional information, see the IBM Consulting website.

IBM Technology Support Services (TSS)

TSS provides Proactive Support services for IBM Z, giving you a single point of contact, control and escalation. This integrated service offers trained specialists who monitor and maintain technology from IBM and strategic suppliers such as The Linux Foundation, helping clients avoid the need to manage multiple suppliers and facilitating simpler, more cost-effective support. IBM's long, successful history of robust technical support combines with access to IBM product development and engineering labs to help provide more efficient advice and problem-solving. Proactive Support includes client advocates who help coordinate responses for a more personalized remote support solution. Specialists familiarize themselves with the clients unique IT environment to help speed the identification and resolution of issues.

For more details on IBM Proactive Support, see the Optimize your IBM Z Environment website.

TSS also offers extensive IT maintenance and support services that cover more than one niche of a client's environment. TSS covers products from IBM and other OEMs, including servers, storage, network, appliances, and software to help clients ensure high availability across their data center and hybrid cloud environment. For details on available services, see the Technology support for hybrid cloud environments website.

IBM Z Forward Acceleration Initiative

IBM Z Forward Acceleration Initiative helps clients make the most of their IBM Z investment, accelerate the transformation of their IT infrastructure, and expedite the adoption of new IBM Z and Linux on IBM Z technologies. The program rewards clients who purchase qualifying IBM Z and Linux on IBM Z systems with rewards that can be redeemed for services in the areas of: cyber security and resiliency, hybrid cloud and platform modernization, and Linux. Rewards are included with the purchase of qualifying systems and are provided at no additional charge for clients with earned rewards. Systems Lab Services provides the services associated with the IBM Z Forward Acceleration Initiative. Rewards must be used within a specific timeframe and other limitations apply. May not be combined with other offers.

An Authorization to Provide Services is required for all IBM Z Forward Acceleration Initiative Reward Engagements.

For additional information, see the IBM Z Forward Acceleration Initiative website.

IBM Expert Labs

Expert Labs can help clients accelerate their projects and optimize value by leveraging their deep technical skills and knowledge. With more than 20 years of industry experience, these specialists know how to overcome the biggest challenges to deliver business results that can have an immediate impact.

Expert Labs' deep alignment with IBM product development allows for a strategic advantage as they are often the first in line to get access to new products, features, and early visibility into roadmaps. This connection with the development enables them to deliver First of a Kind implementations to address unique needs or expand a client's business with a flexible approach that works best for their organization.

For additional information, see the IBM Expert Labs website.

IBM Security Expert Labs

With extensive consultative expertise on IBM Security software solutions, Security Expert Labs helps clients and partners modernize the security of their applications, data, and workforce. With an extensive portfolio of consulting and learning services, Expert Labs provides project-based and premier support service subscriptions.

These services can help clients deploy and integrate IBM Security software, extend their team resources, and help guide and accelerate successful hybrid cloud solutions, including critical strategies such as zero trust. Remote and on-premises software deployment assistance is available for IBM Cloud Pak$^{(R)}$ for Security, IBM Security QRadar$^{(R)}$/QRoC, IBM Security SOAR/Resilient$^{(R)}$, IBM i2$^{(R)}$, IBM Security Verify, IBM Security Guardium$^{(R)}$, and IBM Security MaaS360$^{(R)}$.

For more information, contact Security Expert Labs at sel@us.ibm.com.

For additional information, see the IBM Security Expert Labs website.

IBM support

For installation and technical support information, see the IBM Support Portal.

Additional support

IBM Client Engineering for Systems

Client Engineering for Systems is a framework for accelerating digital transformation. It helps you generate innovative ideas and equips you with the practices, technologies, and expertise to turn those ideas into business value in weeks. When you work with Client Engineering for Systems, you bring pain points into focus. You empower your team to take manageable risks, adopt leading technologies, speed up solution development, and measure the value of everything you do. Client Engineering for Systems has experts and services to address a broad array of use cases, including capabilities for business transformation, hybrid cloud, analytics and AI, infrastructure systems, security, and more. To learn more, see the IBM Client Engineering website. Contact Client Engineering at sysgarage@ibm.com.

Technical information

EMC conformance

- ANSI C63.4 (2014) with FCC Method 47 CFR Part 15, Subpart B (USA)
- ICES-003 Issue 7 (October 2020) (Canada)
- EN 55032 (2015) + AC (2016) and EN 55035 (2017) (CE Mark Compliance for European Union Countries)
- KS C 9832:2019 and KS C 9835:2019 (Korean EMC Standards)

- VCCI-CISPR 32 (2016) (Japan EMI Regulations)
- CNS 13438 (2006) (up to 6GHz) (Taiwan BSMI EMC Standard)
- AS/NZS CISPR 32:2013 (Australia and New Zealand)
- GB 9254-2008 & GB 17625.1-2012 if applicable (People's Republic of China EMC Standards)
- SASO ICCP Document No. EMC.CVG (Saudi Arabia)
- ГОСТ 30805.22-2013 (CISPR 22:2006), ГОСТ CISPR 24-2013 (CISPR 24:2010), GOST R 51317.3.X Series (Eurasian Economic Union EMC Standards)

Specified operating environment

Physical specifications

The **Physical Specifications** for IBM z16™ Model A01 are now available in the Library section of Resource Link in the Installation Manual for Physical Planning (IMPP).

This information can be obtained at Resource Link .

Using the instructions on the Resource Link panels, obtain a user ID and password.

Resource Link has been designed for easy access and navigation.

Operating environment

The **Operating Environment information** for IBM z16™ Model A01 is now available in the Library section of Resource Link in the Installation Manual for Physical Planning (IMPP).

This information can be obtained at Resource Link .

Using the instructions on the Resource Link panels, obtain a user ID and password.

Resource Link has been designed for easy access and navigation.

Hardware requirements

The hardware requirements for the IBM Z servers, features, and functions are identified. A new driver level is required.

HMC 2.16.0 plus Machine Change Levels (MCLs) and the Support Element 2.16.0 are planned to be available on May 31, 2022. You should review the PSP buckets for minimum MCLs and software PTF levels before IPLing operating systems.

HMC 2.16.0 Supported CPCs

Machine Family	Machine Type	Firmware Driver	SE Version
IBM z16	3931	51	2.16.0
IBM z15	8561, 8562	41	2.15.0
IBM z14 M0x/LMx	3906	36	2.14.1
IBM z14 ZR1/LR1	3907	36	2.14.1

For HMC 2.16.0, there will no longer be support to configure NTP with Autokey because Autokey is known to not be secure and it is not supported.

On HMCs prior to 2.16.0, access to NTP used to have MD5 as the only supported hashing algorithm. MD5 is no longer secure, official support for MD5 has been withdrawn and its use is discouraged. For HMC 2.16.0, SHA-512 will be the default hashing algorithm to be selected for new defines. MD5 will be allowed because both the server and client must match and this change needs to be communicated with external NTP server owners.

Software requirements

IBM z16 requires at a minimum:

- z/OS 2.5 with PTFs.*
- z/OS 2.4 with PTFs.*
- z/OS 2.3 with PTFs.*
- z/OS 2.2 with PTFs (an extended service contract is required).

  * IBM z/OS 2.3, or higher, with IBM z16 will require a minimum of 8 GB of memory. When running as a z/VM guest or on an IBM System $z^{(R)}$ Personal Development Tool, a minimum of 2 GB will be required for z/OS 2.3. If the minimum is not met, a warning WTOR will be issued at IPL. Continuing with less than the minimum memory could impact availability. A migration health check was introduced for z/OS 2.2 with PTFs to warn you when an LPAR on an IBM z16 system has been configured with less than 8 GB.

- z/VM 7.3.
- z/VM 7.2 with PTFs.
- z/VM 7.1 with PTFs.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^{n} 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support running the following Linux on IBM Z distributions on IBM z16:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.
  - The support statements for IBM z16 also cover the KVM hypervisor on distribution levels that have KVM support.

  For minimum required and recommended distribution levels, see the IBM Z website. Note: The IBM product "KVM for IBM Z " is out of service and no longer available from IBM. KVM technology is now provided as part of the distributions.

The following software requirements are listed for features and capabilities supported on IBM z16:

FICON Express32S (CHPID type FC) , when utilizing FICON or Channel-to-Channel (CTC), requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^{n} 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.

– Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

FICON Express32S (CHPID type FC), for support of zHPF single track operations, requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.3 with PTFs.
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  – SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  – Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  – Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

FICON Express32S (CHPID type FC), for support of zHPF multitrack operations, requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  – SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  – Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  – Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

FICON Express32S (CHPID type FCP), for support of SCSI devices, requires at a minimum:

- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.
- Linux on IBM Z-IBM plans to support:
  – SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  – Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.

– Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

FICON Express32S (CHPID type FCP) support of hardware data router requires at a minimum:

- z/VM 7.3 for guest exploitation.
- z/VM 7.2 for guest exploitation.
- z/VM 7.1 for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

T10-DIF support by the FICON Express32S features, when defined as CHPID type FCP, require at a minimum:

- z/VM 7.3 for guest exploitation.
- z/VM 7.2 for guest exploitation.
- z/VM 7.1 for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

OSA-Express7S GbE LX 1.2 (#0454) and GbE SX 1.2 (#0455) require at a minimum:

CHPID type OSC:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

CHPID type OSD:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.

- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE[n] 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

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

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE[n] 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

OSA-Express7S 10 GbE LR 1.2 (#0456) and 10 GbE SR 1.2 (#0457) require at a minimum:

CHPID type OSD:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE[n] 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.

- Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
- Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

OSA-Express7S 25 GbE LR 1.2 (#0460) and OSA-Express7S 25 GbE SR 1.2 (#0459) require at a minimum:

CHPID type OSD:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^{n} 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

OSA-Express7S 1000BASE-T Ethernet 1.2 (#0458) requires at a minimum:

CHPID type OSC supporting TN3270E and non-SNA DFT:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^{n} 6.3.
- z/TPF 1.1 with PTFs.

CHPID type OSD with exploitation of two ports per CHPID:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^{n} 6.3.
- z/TPF 1.1 with PTFs.

- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

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

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2.
- z/VM 7.1.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

Checksum offload for IPv6 packets (CHPID type OSD):

- z/OS 2.5.
- z/OS 2.4.
- z/OS 2.3.
- z/OS 2.2 (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 for guest exploitation.
- z/VM 7.1 for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

Checksum offload for LPAR-to-LPAR traffic for IPv4 and IPv6 packets (CHPID type OSD):

- z/OS 2.5.
- z/OS 2.4.
- z/OS 2.3.
- z/OS 2.2 (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 for guest exploitation.
- z/VM 7.1 for guest exploitation.
- Linux on IBM Z-IBM plans to support:

- SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
- Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
- Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

Large Send for IPv6 packets (CHPID type OSD):

- z/OS 2.5.
- z/OS 2.4.
- z/OS 2.3.
- z/OS 2.2 (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 for guest exploitation.
- z/VM 7.1 for guest exploitation.

CHPID type OSE supporting two or four ports per feature:

- z/OS 2.5.
- z/OS 2.4.
- z/OS 2.3.
- z/OS 2.2 (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 for guest exploitation.
- z/VM 7.1 for guest exploitation.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.

Crypto Express8S (2 HSM) (#0908) Toleration , which treats Crypto Express8S cryptographic coprocessors and accelerators as Crypto Express7S coprocessors and accelerators, requires at a minimum:

- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

Crypto Express8S (1 HSM) (#0909) Toleration requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.
- z/VSE 6.2 with PTFs.

- 21st Century Software VSEn 6.3.
- z/TPF 1.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

Crypto Express8S (1 HSM) (#0909) support of VISA Format Preserving Encryption requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.

Crypto Express8S (1 HSM) (#0909) Exploitation requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs.
- z/OS 2.3 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs.
- z/OS 2.2 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs (an extended service contract is required).
- z/VM 7.3 for guest exploitation and exploitation within the z/VM TLS/SSL server.
- z/VM 7.2 with PTFs for guest exploitation and exploitation within the z/VM TLS/ SSL server.
- z/VM 7.1 with PTFs for guest exploitation and exploitation within the z/VM TLS/ SSL server.
- Linux on IBM Z-IBM is working with its Linux distribution partners to provide support in future distribution releases.

Crypto Express8S (1 HSM) (#0909) support of PCI-HSM compliance requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs.
- z/OS 2.3 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs.
- z/OS 2.2 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.

10 GbE RoCE Express3 SR (#0440), 10 GbE RoCE Express3 LR (#0441) for Shared Memory Communications - Remote Direct Memory Access (SMC-R) requires at a minimum:

- z/OS 2.5.
- z/OS 2.4 with PTFs.

- z/OS 2.3 with PTFs.
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service and RHEL 8.4 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

25 GbE RoCE Express3 SR (#0452) and 25 GbE RoCE Express3 LR (#0453) for Shared Memory Communications - Remote Direct Memory Access (SMC-R) requires at a minimum:

- z/OS 2.5.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service and RHEL 8.4 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

10 GbE RoCE Express3 SR (#0440), 10 GbE RoCE Express3 LR (#0441) for Ethernet communications (which does not require a peer OSA) including Single Root I/O Virtualization (SR-IOV) requires at a minimum:

- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service and RHEL 8.4 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

25 GbE RoCE Express3 SR (#0452) and 25 GbE RoCE Express3 LR (#0453) for Ethernet communications (which does not require a peer OSA) including Single Root I/O Virtualization (SR-IOV) requires at a minimum:

- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service and RHEL 8.4 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

10 GbE RoCE Express3 SR (#0440), 10 GbE RoCE Express3 LR (#0441) for TCP/IP requires at a minimum:

- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.

- z/VM 7.1 with PTFs for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service and RHEL 8.4 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

25 GbE RoCE Express 3 SR (#0452) and 25 GbE RoCE Express3 LR (#0453) for TCP/IP requires at a minimum:

- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service and RHEL 8.4 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

IBM Integrated Coupling Adapter Fanout (ICA SR1.1) (#0176) requires at a minimum:
- z/OS 2.5.
- z/OS 2.4.
- z/OS 2.3.
- z/OS 2.2 (an extended service contract is required).
- z/VM 7.3 to define, modify, and delete CHPID type CS5 when z/VM is the controlling LPAR for dynamic I/O.
- z/VM 7.2 to define, modify, and delete CHPID type CS5 when z/VM is the controlling LPAR for dynamic I/O.
- z/VM 7.1 to define, modify, and delete CHPID type CS5 when z/VM is the controlling LPAR for dynamic I/O.

Support for 384 Coupling CHPIDs, 96 physical ICA SR coupling links, and 64 ICP internal coupling channels requires at a minimum:
- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).

Support for CFLEVEL 25 coupling facility enhancements requires at a minimum:
- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3 for virtual coupling facility guest exploitation.
- z/VM 7.2 for virtual coupling facility guest exploitation.
- z/VM 7.1 for virtual coupling facility guest exploitation.

Coupling Express2 LR (#0434) requires at a minimum:
- z/OS 2.5.
- z/OS 2.4 with PTFs.

- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3 to define, modify, and delete CL5 CHPID types when z/VM is the controlling LPAR for dynamic I/O.
- z/VM 7.2 with PTFs to define, modify, and delete CL5 CHPID types when z/VM is the controlling LPAR for dynamic I/O.
- z/VM 7.1 with PTFs to define, modify, and delete CL5 CHPID types when z/VM is the controlling LPAR for dynamic I/O.

zHyperLink Express1.1 (#0451) Reads support requires at a minimum:

- z/OS 2.5.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- Db2 11 plus PTFs.

zHyperLink Express1.1 (#0451) Writes support requires at a minimum:

- z/OS 2.5.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- Db2 12 plus PTFs.

CPU Measurement Facility requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/VM 7.3.
- z/VM 7.2 with PTFs.
- z/VM 7.1 with PTFs.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

  Note: IBM is working with its Linux distribution partners to provide support for new IBM z16 measurements in future distribution releases.

Quantum-safe API support requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs.
- z/OS 2.3 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs.
- z/OS 2.2 with Cryptographic Support for z/OS 2.2 --z/OS 2.4 (HCR77D1) with PTFs (an extended service contract is required).
- z/VM 7.3 for guest exploitation.
- z/VM 7.2 with PTFs for guest exploitation.
- z/VM 7.1 with PTFs for guest exploitation.

IBM Fibre Channel Endpoint Security requires at a minimum:

- z/OS 2.5.
- z/OS 2.4 with PTFs.
- z/OS 2.3 with PTFs.
- z/OS 2.2 with PTFs (an extended service contract is required).
- z/VM 7.3.
- z/VM 7.2 with PTFs.
- z/VM 7.1 with PTFs.
- z/VSE 6.2 with PTFs.
- 21st Century Software VSE^n 6.3.
- Linux on IBM Z-IBM plans to support:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat RHEL 9.0 with service and Red Hat RHEL 8.4 with service.
  - Canonical: Ubuntu 21.04 LTS, or later.

Secure Execution for Linux requires support in the KVM host and the KVM guest, at a minimum:

- IBM supports running the following Linux on IBM Z distributions as a KVM host on IBM z16:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service and RHEL 8.4 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.
- IBM supports running the following Linux on IBM Z distributions as a KVM guest on IBM z16:
  - SUSE Linux Enterprise Server: SLES 15 SP3 with service and SLES 12 SP5 with service.
  - Red Hat Enterprise Linux: RHEL 9.0 with service, RHEL 8.4 with service, and RHEL 7.9 with service.
  - Canonical: Ubuntu 20.04 LTS with service and Ubuntu 22.04 LTS with service.

System Recovery Boost Resiliency enhancements for IBM z16 require at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- All z/OS PTFs associated with System Recovery Boost are identified with the SMP/E FIXCAT of IBM.Function.SystemRecoveryBoost.

IBM Hardware Management Console Enhancements require at a minimum:

- z/OS 2.5 with APAR OA60351.

AI on IBM Z requires at a minimum:

- z/OS 2.5.
- z/OS 2.4 with PTFs.
- z/VM 7.3 for Guest Exploitation.
- z/VM 7.2 with PTFs for Guest Exploitation.
- z/VM 7.1 with PTFs for Guest Exploitation.
- Watson Machine Learning for z/OS 2.
- Watson Machine Learning for z/OS 2.1.
- Red Hat OpenShift Container Platform 4.10.
- IzODA 1.1.0.

IBM Z Integrated Accelerator for AI requires at a minimum:

- z/OS 2.5 with PTFs.
- z/OS 2.4 with PTFs.
- Linux on IBM Z-IBM is working with its Linux distribution partners to provide the zDNN library (available at: https://github.com/IBM/zDNN) for future distribution releases.

IBM Cloud Infrastructure Center requires at a minimum:

- As a managed hypervisor one of the following:
  - z/VM 7.1, or later.
  - KVM based on Red Hat Enterprise Linux (RHEL) 8.4 with service.
- As a host environment on z/VM or Red Hat KVM one of the following:
  - RHEL 8.4 with service.

Red Hat OpenShift Container Platform 4.10 requires at a minimum virtual machines based on one of the following:

- z/VM 7.1, or later.
- KVM based on Red Hat Enterprise Linux (RHEL) 8.4 with service.

IBM Cloud Paks require at a minimum:

- Red Hat OpenShift Container Platform 4.10.

IBM Cloud Pak for Data on IBM Z requires at a minimum:

- Red Hat OpenShift Container Platform 4.10.

IBM Enterprise Key Management Foundation - Web Edition 2.1 requires at a minimum:

- WebSphere$^{(R)}$ Liberty 21.0.0.3.
- Java^{TM} SDK80 SR6 FP26 with APAR PH34993.
- z/OS 2.5.
- z/OS 2.4.
- Db2 12.
- IBM Crypto Express Card (CEX).

Planning information

Client responsibilities

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

Cable orders

Not applicable

Installability

The average installation time for an IBM z16^{tm} 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 IBM z16™ uses the security and auditability features and functions of host hardware, host software, and application software.

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

Terms and conditions

Products - terms and conditions

Warranty period

One year

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.

International Warranty Service

International Warranty Service allows you to relocate any machine that is eligible for International Warranty Service and receive continued warranty service in any country where the IBM machine is serviced. If you move your machine to a different country, you are required to report the machine information to your Business Partner or IBM representative.

The warranty service type and the service level provided in the servicing country may be different from that provided in the country in which the machine was purchased. Warranty service will be provided with the prevailing warranty service type and service level available for the eligible machine type in the servicing country, and the warranty period observed will be that of the country in which the machine was purchased.

The following types of information can be found on the International Warranty Service website:

- Machine warranty entitlement and eligibility
- Directory of contacts by country with technical support contact information
- Announcement Letters

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

International Warranty Service

International Warranty Service allows you to relocate any machine that is eligible for International Warranty Service and receive continued warranty service in any country where the IBM machine is serviced. If you move your machine to a different

country, you are required to report the machine information to your Business Partner or IBM representative.

The warranty service type and the service level provided in the servicing country may be different from that provided in the country in which the machine was purchased. Warranty service will be provided with the prevailing warranty service type and service level available for the eligible machine type in the servicing country, and the warranty period observed will be that of the country in which the machine was purchased.

The following types of information can be found on the International Warranty Service website

- Machine warranty entitlement and eligibility
- Directory of contacts by country with technical support contact information
- Announcement Letters

Warranty service upgrades

If required, IBM will provide repair service depending on the types of maintenance service specified for the machine. Contact your local representative.

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.

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.

In the United States, contact IBM at 1-800-IBM-SERV (426-7378), in other countries 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 visiting the License Agreement for Machine Code and Licensed Internal Code website.

Specific Machine Type Model:

- 3931-A01

Licensed Machine Code

Not applicable

Other Installed Licensed Code

None

Educational allowance

Not applicable

Prices

For all local charges, contact your IBM representative.

Annual minimum maintenance charges

Not applicable

Model conversion purchase price

From Machine Type	From Model	To Machine Type	To Model	Returned Parts	Continuous Maintenance	Purchase Price
3906	M01	3931	A01	Y	Y	
3906	M02	3931	A01	Y	Y	
3906	M03	3931	A01	Y	Y	
3906	M04	3931	A01	Y	Y	
3906	M05	3931	A01	Y	Y	
8561	T01	3931	A01	Y	Y	

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Not applicable

Regional availability

Australia, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, People's Republic of China, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Fiji, Heard Island and McDonald Islands, Hong Kong, India, Indonesia, Kiribati, Republic of Korea, Lao People's Democratic Republic, Macao, Malaysia, Maldives, Mongolia, Myanmar, Nauru, Nepal, New Zealand, Niue, Norfolk Island, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Timor-Leste, Tokelau, Tonga, Tuvalu, and Vietnam

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Terms of use

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IBM Directory of worldwide contacts

Corrections

(Corrected on May 13, 2022)

Modifications made to Product number and Product charges sections.

(Corrected on April 22, 2022)

Modifications made to Product number and Product charges sections.