

IBM Z Functional Matrix

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IBM Z



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This IBM® Redpaper publication can help you quickly understand the features, functions, connectivity options, and certifications that are available with the IBM z16™, IBM z15®, and IBM z14®.

This publication covers the following topics:

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Note: The intention of this publication is to compare the standard and optional features for various IBM Z® configurations. It does *not* include information about services, requests for price quotation (RPQs), or specific quantities or measurements that are related to performance, memory size, bandwidth, and so on.

For more information about the features and functions that are listed in the tables of this publication, see the system-specific reference documentation.

The following keys are used in the tables in this IBM Redpaper publication:

- ▶ S: Standard
- ▶ O: Optional
- ▶ n: Not supported
- ▶ na: not applicable
- ▶ CF: Carry forward only

Application programming interfaces

System management applications that provide integrated hardware and software management solutions are supported through the console programming interfaces. Detailed information that includes console application programming interface (API) objectives, architecture, data structures, usage, and console-managed object definitions and identifications is provided. An API is a set of routines, protocols, and tools that are used for building software applications.

The API interfaces provide the capability to use object-based, industry-standard programming interfaces instead of building home-grown, release-specific programs for collecting the hardware information that is needed to provide an integrated hardware and software system management solution. The firmware support for the APIs is listed in Table 1.

Table 1 Firmware support for APIs

API ^a	IBM z16	IBM z15	IBM z14
Hardware Management Console (HMC) Web Services (Web Services) ^b	S	S	S
Simple Network Management Protocol (SNMP)	S	S	S
Secure Service Container (SSC)	S	S	S
Base Control Program internal interface (BCPii)	S	S	S
Ability to use APIs to access Unified Resource Manager function	n	n	S
HMC Common Information Model (CIM)	n	n	n

a. Consult the HMC Web Services API, documents: *Hardware Management Console Web Services API (V2.14.1)*, SC27-2637 for IBM z14, *Hardware Management Console Web Services API (V2.15.0)*, SC27-2638 for IBM z15, and *Hardware Management Console Web Services API (V2.16.0)*, SC27-2642 for IBM z16. You can find the documents on [IBM Resource Link®](#) (IBM user ID required).

b. Web Services are disabled by default for security reasons and must be enabled by the user.

Cryptographic features

The hardware cryptographic services that are provided with IBM Z platforms are intended to cover the full range of industry standard cryptographic operations.

The Trusted Key Entry (TKE) workstation is another optional feature that consists of an IBM specific workstation that provides a highly secure environment for the centralized management of the Crypto Express features (in one or more systems) to which the TKE workstation has TCP/IP connectivity.

The following types of hardware cryptographic features are available with IBM Z platforms:

- ▶ CP Assist for Cryptographic Functions (CPACF) is implemented as a set of cryptographic instructions in IBM Z firmware to improve performance when encrypting and decrypting data.
- ▶ The Crypto Express PCIe feature is an optional feature that is plugged into the PCIe I/O drawers or PCIe+ IO drawers.

The cryptographic functions for CPACF are listed in Table 2.

Table 2 CPACF cryptography functions

Cryptographic functions	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Secure Hash Standard SHA1	S	S	S	S	S	S
Secure Hash Standard SHA2 (224, 256, 384, and 512)	S	S	S	S	S	S
Secure Hash Standard SHA3 (224, 256, 384, and 512)	S	S	S	S	S	S
GHASH	S	S	S	S	S	S
SHAKE support for 128-bit and 256-bit	S	S	S	S	S	S
CP Assist Cryptographic Function^a						
Advanced Encryption Standard (AES) AES-128; AES-192, and AES-256	S	S	S	S	S	S
Data Encryption Standard (DES) and triple DES (TDES)	S	S	S	S	S	S
Message authentication code (MAC)	S	S	S	S	S	S
True Random Number Generation (TRNG)	S	S	S	S	S	S
Deterministic Random Number Generation (DRNG) (NIST SP-800-90A SHA-512 based)	S	S	S	S	S	S
Pseudo Random Number Generator (PRNG)	S	S	S	S	S	S
Cipher Message with CFB (KMF)	S	S	S	S	S	S
Cipher Message with Counter (KMCTR)	S	S	S	S	S	S
Cipher Message with OFB (KMO)	S	S	S	S	S	S
Elliptic Curve Cryptography (ECC)	S	S	S	S	S	S
Odessa, Elliptic Curve Diffie-Hellman (ECDH) - Support for NIST P256, NIST P386, NIST P 521	S	S	S	S	na	na
Odessa for Ed25519 and Ed448 curves	S	S	na	na	na	na
ECDH for X25519 and X448 curves	S	S	na	na	na	na

a. The enablement feature (Feature Code 3863) for CPACF is a no-charge option.

The Crypto Express functions are listed in Table 3.

Table 3 *Crypto Express functions*

Crypto functions	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Common Cryptographic Architecture (CCA)	S	S	S	S	S	S
Concurrent internal code changes on segment 3 to add or update a CCA application	S	S	S	S	S	S
Compute Intermediate Message Digest (CIMD)	S	S	S	S	S	S
Enable or disable the encrypt DEA key or encrypt AES key function by using the Support Element (SE)	S	S	S	S	S	S
Europay MasterCard Visa (EMV)	S	S	S	S	S	S
Protected key CPACF for high-performance data encryption	S	S	S	S	S	S
Remote key loading for ATM/POS	S	S	S	S	S	S
RSA – Optimal Asymmetric Encryption Padding (OAEP) method with SHA-256	S	S	S	S	S	S
Secure Keyed-Hash Message Authentication Code (HMAC)	S	S	S	S	S	S
TR-31 wrapping method for secure key exchange	S	S	S	S	S	S
Crypto Automation Toggling without operating system toleration ^a	S	S	n	n	n	n
OSA Automation Toggling without operating system toleration ^b	S	S	n	n	n	n

a. Provides a method to serially config on/off Crypto features. Requires Crypto Express adapters to be configured redundantly.

b. Provides a method to serially config on/off OSA features. Requires OSA Express adapters to be configured redundantly.

The optional Crypto Express features are listed in Table 4.

Table 4 *Crypto Express features*

Crypto Adapters features, functions, or attributes	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Maximum domains supported	85	40	85	40	85	40
Maximum operational key part registers support	512	512	512	512	512	512
Crypto Express8S features						

Crypto Adapters features, functions, or attributes	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
Crypto Express8S feature Feature Code 0908 (2xHSMs) Crypto Express8S feature Feature Code 0909 (1xHSM)	O	O	n	n	n	n
Quantum-safe cryptography	S	S	n	n	n	n
Quantum-safe APIs	S	S	n	n	n	n
AES Galois Message Authentication Code (GMAC), AES Galois Counter Mode (GCM), AES XEX Tweakable Block Ciphertext Stealing (XTS), and cipher-based MAC (CMAC)	S	S	S	S	na	na
Key generation for NIST, Ed, and X-Curves	S	S	na	na	na	na
Enterprise Public Key Cryptography Standards #11 (EP11)	S	S	na	na	na	na
Maximum domains	85	40	na	na	na	na
Maximum operational key part registers	512	512	na	na	na	na
Payment Card Industry (PCI) Hardware Security Module (HSM) PCI-HSM	S	S	S	S	na	na
Prime Number Generator (PNG)	S	S	S	S	na	na
Secure AES GCM encryption mode	S	S	na	na	na	na
TRNG	S	S	na	na	na	na
Visa Data Secure Platform Point to Point Encryption (P2PE)	S	S	na	na	na	na
Visa Format Preserving Encryption	S	S	na	na	na	na
CRYSTALS-Dilithium 6.5 and 8.7 (Round 2 and Round 3)	S	S	n	n	n	n
CRYSTALS-Kyber 1024 (Round 2)	S	S	n	n	n	n
Crypto Express7S features						
Crypto Express7 feature 1xHSM Feature Code 0899 Crypto Express7 feature 2xHSM Feature Code 0898	CF	CF	O	O	na	na
AES GMAC, AES GCM, AES XTS, and CMAC	S	S	S	S	na	na
EP11	S	S	S	S	na	na
Maximum domains	85	40	85	40	na	na
Maximum operational key part registers	512	512	512	512	na	na
PCI-HSM	S	S	S	S	na	na

Crypto Adapters features, functions, or attributes	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
PNG	S	S	S	S	na	na
Secure AES GCM encryption mode	S	S	S	S	na	na
TRNG	S	S	S	S	na	na
Visa Data Secure Platform P2PE	S	S	S	S	na	na
Visa Format Preserving Encryption	S	S	S	S	na	na
CRYSTALS-Dilithium 6.5 (Round 2)	S	S	n	n	n	n
Crypto Express6S features						
Crypto Express6 feature Feature Code 0893	CF	CF	CF	CF	O	O
AES GMAC, AES GCM, AES XTS, and CMAC	S	S	S	S	S	S
Elliptic Curve Digital Signature Algorithm (ECDSA) and ECDH	S	S	S	S	S	S
EP11	S	S	S	S	S	S

The TKE Workstation features are listed in Table 5.

Table 5 Trusted Key Entry

TKE Workstation^{a,b} features, functions, or attributes	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
TKE additional smart cards (10 pack) Feature Code 0900	O	O	O	O	O	O
TKE smart card reader Feature Code 0891	O	O	O	O	O	O
TKE Tower or TKE workstation	O	O	O	O	O	O
TKE Rack-Mounted	O	O	O	O	O	O
TKE 10.0 Licensed Internal Code (LIC)	S	S	S	S	S	S
TKE 9.2 Licensed Internal Code	S	S	S	S	S	S
PCI-compliant with CCA 6.3	S	S	S	S	S	S
TKE 9.1 Licensed Internal Code or TKE 9.0 LIC (superseded by TKE 9.1 LIC)	CF	CF	CF	CF	CF	CF
	CF	CF	CF	CF	CF	CF
Key material copy to alternative zone	S	S	S	S	S	S

TKE Workstation^{a,b} features, functions, or attributes	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Save TKE data directory structure with files to USB	S	S	S	S	S	S
Create key parts without opening a host	S	S	S	S	S	S
Audit Log for Privileged Mode Access ID	S	S	S	S	S	S
Secure key entry on EP11	S	S	S	S	S	S
X.509 certificates manager for domains	S	S	S	S	S	S
Domain mode management	S	S	S	S	S	S
Set clock	S	S	S	S	S	S
Domain-specific Host Crypto Module Audit Log management	S	S	S	S	S	S
Domain-specific roles and authorities	S	S	S	S	S	S
Domain Cloning	S	S	S	S	S	S
Certificate authority wizards (smart card wizards for the TKE zone and for configuration migrations)	S	S	S	S	S	S
Coordinated Master Key roll from TKE	S	S	S	S	S	S

a. This feature is optional.

b. TKE must be at a later or the same level as the latest Crypto Express feature that is installed in the systems (see Table 6).

Table 6 shows the supported Crypto Express feature codes and the TKE-related LIC release.

For some functions, requirements must be considered, for example, the characterization of a Crypto Express adapter in EP 11 mode always requires a TKE.

The TKE is unaware of where the host crypto module is installed, that is, the TKE does not consider whether a Crypto Express is installed in an IBM z16, IBM z15, or IBM z14. Therefore, the TKE release LIC must support the specific crypto module.

Table 6 TKE compatibility matrix

TKE workstation	TKE Release LIC	9.0	9.1	9.2	10.0
	Hardware Feature Code ^a	0085 or 0086	0085 or 0086	0087 or 0088	0145 or 0144
	Licensed Internal Code Configuration Control (LISCCC)	0879	0880	0881	0882
	Smart Card Reader	0885 0891	0891	0891	0891
	Smart Card	0884 0892	0900	0900	0900
Manage Host Crypto Module	CEX8C (CCA)	no	no	no	Yes
	CEX8P (EP11)	no	no	no	Yes
	CEX7C (CCA)	no	no	Yes	Yes
	CEX7P (EP11)	no	no	Yes	Yes
	CEX6C (CCA)	Yes	Yes	Yes	Yes
	CEX6P (EP11)	Yes	Yes	Yes	Yes
	CEX5C (CCA)	Yes	Yes	Yes	Yes
	CEX5P (EP11)	Yes	Yes	Yes	Yes

a. TKE Hardware features can be carried forward and upgraded to support the latest Crypto Express feature that is installed in the system.

I/O characteristics and features

The system input/output (I/O) operations for the IBM Z platform are handled by the channel subsystem (CSS). The role of the CSS is to control communication between internal or external channels and control units and devices.

From a central processor standpoint, the CSS is independent of the processors of the IBM Z platform. Therefore, I/O within IBM Z servers can be done asynchronously. This requirement is critical in a system that is designed to handle massive numbers of concurrent transactions.

IBM Z technology can handle a high volume of transactions and I/O operations in parallel. Because of the ability to do parallel I/O operations, IBM Z configurations can serve many different devices, such as disk storage, printers, other attached computers, and networks.

The I/O characteristics are listed in Table 7.

Table 7 I/O characteristics

I/O features, functions, or attributes	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Cancel Subchannel (XSCH)	S	S	S	S	S	S
Dynamic I/O configuration	S	S	S	S	S	S
Dynamic I/O configuration for stand-alone CF ^a	S	S	S	S	S	S
Dynamic I/O configuration for stand-alone Linux on Z and z/TPF ^b	S	S	n	n	n	n
Dynamic reconnect	S	S	S	S	S	S
Fiber Quick Connect (FQC)	O	S	O	O	O	O
Nondisruptive I/O removal	S	S	S	S	S	S
PCIe I/O drawers ^c	n	n	n	n	O	n
PCIe+ I/O drawer ^c	O	O	O	O	n	O
PCIe+ Gen3 Fanout	S	S	S	S	n	n
System-initiated CHPID reconfiguration	S	S	S	S	S	S
IBM z/OS® Discovery and Auto Configuration (zDAC)	S	S	S	S	S	S
Logical Channel Subsystems (LCSSs): up to 256 CHPIDs per LCSS						
Multiple Image Facility (MIF)	S	S	S	S	S	S
Support of LCSS (maximum supported)	S(6)	S(3)	S(6)	S(3)	S(6)	S(3)
Subchannel sets per LCSS (maximum supported)	S(4)	S(3)	S(4)	S(3)	S(4)	S(3)

a. Dynamic I/O for stand-alone CF is available with IBM z14 Driver Level 36, IBM z15 Driver Level 41, or IBM z16 Driver Level 51 central processor complexes (CPCs). Requires Hardware Configuration Definition (HCD) and I/O configuration program (IOCP) program temporary fixes (PTFs).

b. Dynamic I/O for stand-alone Linux on Z and z/TPF requires 2.3 or higher z/OS partition with APAR OA65559 applied, running on an IBM z16 and Linux on Z and z/TPF also running on IBM z16. Both z16 CPCs require proper firmware level (Bundle S24 or higher). This configuration continues to support stand-alone CF Dynamic I/O activations.

c. At least one PCIe I/O drawer or PCIe+ I/O drawer is required, depending on the system (except for certain configurations that are used as a stand-alone Coupling Facility (CF)).

Storage connectivity

Storage connectivity is provided on the IBM Z platform through IBM FICON® Express and the IBM zHyperLink Express features.

FICON Express features follow the established Fibre Channel (FC) standards to support data storage and access requirements.

zHyperLink Express was created to provide fast access to data through direct, low-latency connections between the IBM Z platform and storage. A zHyperLink channel does not replace a FICON channel, but complements it. FICON remains the main data driver and is mandatory for zHyperLink usage.

The supported storage connectivity functions for FICON are listed in Table 8.

Table 8 FICON storage connectivity functions

Functions	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
CHPID Type FC						
FICON multihop cascaded directors (maximum 4)	S	S	S	S	S	S
FICON channel-to-channel (CTC)	S	S	S	S	S	S
FICON Dynamic Routing (FIDR)	S	S	S	S	S	S
FICON purge path extended	S	S	S	S	S	S
Forward Error Correction (FEC) for FICON Express16S and later	S	S	S	S	S	S
High-Performance FICON for IBM Z (zHPF)	S	S	S	S	S	S
High FICON (zHPF) Extended Distance II	S	S	S	S	S	S
Modified indirect address word (MIDAW) facility	S	S	S	S	S	S
Number of devices per FICON channel	32 K	32 K	32 K	32 K	32 K	32 K
IBM Fibre Channel Endpoint Security (Feature Code 1146) ^a	O	O	O	n	na	na
CHPID Type Fibre Channel Protocol (FCP)						
FCP channels – T10-DIF support	S	S	S	S	S	S
FCP full-fabric connectivity to SCSI storage devices	S	S	S	S	S	S
FCP program directed restart	S	S	S	S	S	S
FCP SCSI IPL	S	S	S	S	S	S
FCP support for IBM z/VM®, IBM z/VSE ^b ®, and Linux on IBM Z (attach to SCSI devices)	S	S ^b	S	S	S	S

Functions	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
N_Port ID Virtualization (NPIV) for FCP	S	S	S	S	S	S
Worldwide port name (WWPN) prediction tool for virtual ports	S	S	S	S	S	S
WWPN prediction tool for physical ports	S	S	S	S	S	S
IBM Fibre Channel Endpoint Security (Feature Code 1146) ^a	O ^c	O ^d	O ^c	n	na	na

- a. Requires Feature Code 3863 (CPACF enablement). Subject to export regulations.
- b. IBM z16 A01 is the last IBM Z supported by IBM z/VSE 6.2. IBM z16 A02 and IBM z16 AGZ are not supported by IBM z/VSE 6.2. ([See 21 Century Software VSEⁿ V6.3](#)).
- c. FICON Express32S, FICON Express16SA - Encryption of Data in Flight and Endpoint Authentication. FICON Express16S+ supports Endpoint Authentication only.
- d. This feature (Feature Code 1146) is supported by FICON Express32S (Facts 0461 and 0462); new build IBM z16 A02 and IBM z16 AGZ servers; and FICON Express16S+ (Facts 0427 and 0428) as carry forward. FICON Express16SA is not supported on IBM z16 A02 or IBM z16 AGZ.

The optional FICON Express features are listed in Table 9.

Table 9 IBM FICON features

IBM FICON features	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
FICON Express32S^a (8, 16, or 32 Gbps)						
10 KM LX (two ports) Feature Code 0461	O	O	n	n	n	n
SX (two ports) Feature Code 0462	O	O	n	n	n	n
FICON Express16SA^a (8 or 16 Gbps)						
10 KM LX (two ports) Feature Code 0436	CF	n	O	n	n	n
SX (two ports) Feature Code 0437	CF	n	O	n	n	n
FICON Express16S+^a (4, 8, or 16 Gbps)						
10 KM LX (two ports) Feature Code 0427	CF	CF	CF	O	O	O
SX (two ports) Feature Code 0428	CF	CF	CF	O	O	O
FICON Express16S (4, 8, or 16 Gbps)						
10 KM LX (two ports) Feature Code 0418	n	n	CF	CF	CF	CF
SX (two ports) Feature Code 0419	n	n	CF	CF	CF	CF
FICON Express8S (2, 4, or 8 Gbps)						
10 KM LX (two ports) Feature Code 0409	n	n	CF	CF	CF	CF

IBM FICON features	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
SX (two ports) Feature Code 0410	n	n	CF	CF	CF	CF

a. Both ports on this FICON Express feature must be defined as the same CHPID type (FC or FCP).

The supported zHyperLink functions and optional features are listed in Table 10.

Table 10 IBM zHyperLink functions and features

CHPID type HYL	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
zHyperLink read support	S	S	S	S	S	S
zHyperLink write support ^a	S	S	S	S	S	S
zHyperLink Express features						
zHyperLink Express (Feature Code 0431)	CF	CF	CF	CF	O	O
zHyperLink Express 1.1 (Feature Code 0451)	O	O	O	O	n	n

a. Support for zHyperLink writes requires compatible levels of IBM Storage DS8000® hardware and firmware R8.5.1 or later, and IBM Db2® 12 with PTFs.

Network connectivity

High-speed network connectivity between the IBM Z platform and external networks is supported by Open Systems Adapter-Express (OSA-Express) features and Remote Direct Memory Access (RDMA) over Converged Ethernet Express (RoCE Express) features. Internal connections for IBM Z platforms are provided through fast memory-to-memory communications by using HiperSockets and Internal Shared Memory (ISM).

Network connectivity functions for OSA-Express are listed in Table 11.

Table 11 Network connectivity functions

Functions	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
640 TCP/IP addresses	S	S	S	S	S	S
Checksum offload	S	S	S	S	S	S
Display OSAINFO for z/OS	S	S	S	S	S	S
Inbound workload queuing for z/OS	S	S	S	S	S	S
Large send	S	S	S	S	S	S
Link aggregation for z/VM	S	S	S	S	S	S
OSA dynamic LAN idle	S	S	S	S	S	S
OSA-Express Network Traffic Analyzer	S	S	S	S	S	S
PCIe Interconnect (PCI-IN)	O	O	O	O	O	O
Virtual MAC address support	S	S	S	S	S	S
VLAN management - Generic VLAN Registration Protocol (GVRP) support	S	S	S	S	S	S
Supported CHPID types						
CHPID type OSC for integrated console controller (ICC) for all 1000BASE-T Ethernet features	S	S	S	S	S	S
CHPID type OSC for ICC for OSA-Express 7S 1.2 GbE features	S	n	n	n	n	n
CHPID type OSC for ICC for OSA-Express 7S GbE features	S	n	S	n	na	na
OSA-ICC support for Secure Sockets Layer (SSL)	S	S	S	S	S	S
CHPID type OSD (for Queued Direct I/O (QDIO) supported on all OSA-Express features	S	S	S	S	S	S
QDIO data connection isolation	S	S	S	S	S	S
QDIO Diagnostic Synchronization facility	S	S	S	S	S	S
QDIO Optimized latency mode for the z/OS environment	S	S	S	S	S	S
QDIO Layer 2 and Layer 3	S	S	S	S	S	S
CHPID type OSE for non-QDIO for all 1000BASE-T Ethernet features	S	S	S	S	S	S
CHPID type OSM for intranode management network (INMN) for all 1000BASE-T Ethernet features	n ^a	n ^a	n ^a	n	S	S

Functions	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
CHPID type OSX for all 10 GbE features	n	n	n	n	S	S
CHPID type OSX for 25 GbE ^b features	n	n	n	n	S	S

a. CHPID type OSM is not available for definitions in user configurations. This CHPID type is for internal use with Dynamic Partition.

b. Requires IBM z14 Driver Level 36.

The optional OSA Express features are listed in Table 12.

Table 12 IBM Open Systems Adapters

Features	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
Open Systems Adapter-Express7S 1.2 (OSA-Express7S 1.2)						
25-Gigabit Ethernet Long Reach (LR) (one port) Feature Code 0460 ^a	O	O	n	n	n	n
25-Gigabit Ethernet Short Reach (SR) (one port) Feature Code 0459 ^b	O	O	n	n	n	n
10-Gigabit Ethernet LR (one port) Feature Code 0456	O	O	n	n	n	n
10-Gigabit Ethernet SR (one port) Feature Code 0457	O	O	n	n	n	n
1000BASE-T Ethernet (two ports and one CHPID) Feature Code 0458	O	O	n	n	n	n
Gigabit Ethernet LX (two ports and one CHPID) Feature Code 0454	O	O	n	n	n	n
Gigabit Ethernet SX (two ports and one CHPID) Feature Code 0455	O	O	n	n	n	n
Open Systems Adapter-Express7S (OSA-Express7S)						
25-Gigabit Ethernet SR1.1 (one port) Feature Code 0449 ^b	CF	n	O	n	O	O
25-Gigabit Ethernet SR (one port) Feature Code 0429 ^b	n	n	CF	O	O	O
10-Gigabit Ethernet LR (one port) Feature Code 0444	CF	n	O	n	n	n
10-Gigabit Ethernet SR (one port) Feature Code 0445	CF	n	O	n	n	n
1000BASE-T Ethernet (two ports with one CHPID) Feature Code 0446	CF	n	O	n	n	n

Features	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Gigabit Ethernet LX (two ports and one CHPID) Feature Code 0442	CF	n	O	n	n	O
Gigabit Ethernet SX (two ports and one CHPID) Feature Code 0443	CF	n	O	n	n	n
Open Systems Adapter-Express6S (OSA-Express6S)						
10-Gigabit Ethernet LR (one port) Feature Code 0424	CF	CF	CF	O	O	O
10-Gigabit Ethernet SR (one port) Feature Code 0425	CF	CF	CF	O	O	O
1000BASE-T Ethernet (two ports and one CHPID) Feature Code 0426	CF	CF	CF	O	O	O
Gigabit Ethernet LX (two ports and one CHPID) Feature Code 0422	CF	CF	CF	O	O	O
Gigabit Ethernet SX (two ports and one CHPID) Feature Code 0423	CF	CF	CF	O	O	O
Open Systems Adapter-Express5S (OSA-Express5S)						
10-Gigabit Ethernet LR (one port) Feature Code 0415 ^b	n	n	CF	CF	CF	CF
10-Gigabit Ethernet SR (one port) Feature Code 0416 ^b	n	n	CF	CF	CF	CF
1000BASE-T Ethernet (two ports and one CHPID) Feature Code 0417	n	n	CF	CF	CF	CF
Gigabit Ethernet LX (two ports and one CHPID) Feature Code 0413	n	n	CF	CF	CF	CF
Gigabit Ethernet SX (two ports and one CHPID) Feature Code 0414	n	n	CF	CF	CF	CF

a. Requires a 25 GbE switch. Does not negotiate to 10 Gbps.

b. Requires a 10 GbE switch. Does not negotiate to a lower speed.

Optional IBM Shared Memory Communications features and functions are listed in Table 13.

Table 13 IBM Shared Memory Communications features and functions

Features	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
10 GbE RoCE Express3 SR Feature Code 0440	O	O	n	n	n	n
10 GbE RoCE Express3 LR Feature Code 0441	O	O	n	n	n	n
25 GbE RoCE Express3 SR Feature Code 0452	O	O	n	n	n	n

Features	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
25 GbE RoCE Express3 Long Reach (LR) Feature Code 0453	O	O	n	n	n	n
25 GbE RoCE Express2.1 Feature Code 0450	CF	CF	O	O	n	n
10 GbE RoCE Express2.1 Feature Code 0432	CF	CF	O	O	n	n
25 GbE RoCE Express2 Feature Code 0430	CF	CF	CF	CF	O	O
10 GbE RoCE Express2 Feature Code 0412	CF	CF	CF	CF	O	O
10 GbE RoCE Express Feature Code 0411	n	n	CF	CF	CF	CF
Shared Memory Communications-Remote Direct Memory Access (SMC-R) ^a	S	S	S	S	S	S
Shared Memory Communications-Direct Memory Access (SMC-D)	S	S	S	S	S	S
Shared Memory Communications V2 (SMC-R and DV2) ^b	S	S	S	S	S	S

a. One OSA Express feature that is defined for TCP communications.

b. SMC Version 2 (SMCv2) defines the specifications that enable the multiple-IP subunit capability for SMC.

Supported HiperSockets functions and attributes are listed in Table 14.

Table 14 IBM HiperSockets functions

Functions and attributes	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
32 HiperSockets	S	S	S	S	S	S
Completion queue function	S	S	S	S	S	S
IPv6 support	S	S	S	S	S	S
Integration with intraensemble data network (IEDN)	S	S	S	S	S	S
Layer 2 support	S	S	S	S	S	S
Multiple Write facility	S	S	S	S	S	S
Network Traffic Analyzer	S	S	S	S	S	S

On-demand functions

Capacity Upgrade on Demand (CUoD) is an inherent capability of the IBM Z architecture. You use it to add concurrently capacity and features to the platform. Concurrence depends on the physical available hardware.

Customer Initiated Upgrade (CIU) is a tool that supports ordering permanent and temporary upgrades for their IBM Z hardware. CIU helps to provide CUoD. CUoD upgrades can be ordered through CIU or by using the standard IBM Sales or miscellaneous equipment specification (MES) order process.

Although all CIU upgrades support CUoD, not all CUoD capabilities are available through CIU. For example, a new drawer for IBM Z hardware can be ordered and installed concurrently. This capability is part of the CUoD capabilities of the IBM Z platform. However, it cannot be ordered by using CIU.

Capacity for Planned Event (CPE), Capacity Backup (CBU), and On/Off Capacity on Demand (OOCoD) are temporary upgrade capabilities that allow clients to add capacity to their processor. These upgrades are all part of CUoD. Only one CUoD upgrade capability is available through CIU, which is OOCoD.

The available on-demand functions are listed in Table 15.

Table 15 On-demand functions

On-demand function	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
CUoD						
API for capacity provisioning management (CPM)	S	S	S	S	S	S
CBU	O	O	O	O	O	O
CPE	CF	n	O	O	O	O
CIU-Express with extended staging	O	O	O	O	O	O
Concurrent memory upgrades	O	O	O	O	O	O ^a
Concurrent permanent processor upgrade	O	O	O	O	O	O ^b
Concurrent processor CPC drawer add ^c	O ^c	O ^d	O	O	O	n
Concurrent upgrades while temporary capacity is active	O	O	O	O	O	O
Flexible memory	O	n	O	n	O	n
High Water Mark (HWM) Increase total model capacity and Integrated Facility for Linux (IFL) processors without changing the active model capacity and IFL processors.	O	O	O	O	O	O
OOCoD	O	O	O	O	O	O
Plan-ahead memory	n	n	n	n	O	O

On-demand function	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Up to 8 installed or active (OOCoD, CBU, or CPE ^e) records at any specific time	S	S	S	S	S	S
CBU: Temporary upgrade						
Ability to replenish an ordered record to extend the expiration date, add processing resources, order tests, and restore real activation	S	S	S	S	S	S
Ability to select the contract length (1 - 5 years)	S	S	S	S	S	S
Automatic deactivation at expiration date	S	S	S	S	S	S
Central processors (CPs), IFL processors, Integrated Coupling Facility (ICF) processors, zIIPs, and SAPs	CF	S	O	O	O	O
Manufacturing installation of up to four Flex Capacity and CBU records, when ordered	S	S	S	S	S	S
Maximum of 15 test activations (no-charge and purchased) per CBU record	S	S	S	S	S	S
Number of free test activations equates to the number of years purchased with the CBU record	S	S	S	S	S	S
Replenishment and Reuse record	S	S	S	S	S	S
Subcapacity CBU processors	O	S	O	O	O	S
Uninstalled LICCC records can be staged on the SE	O	O	O	O	O	S
CPE: Temporary upgrade						
CPs, IFL processors, ICF processors, zIIPs, and SAPs	CF	S	O	O	O	O
Manufacturing installation of up to four CPE ^e and CBU records when ordered	S	S	S	S	S	S
Nondisruptive hardware CP capacity setting changes	S	S	S	S	S	S
Select model capacity and type and quantity of engines based on business needs	S	S	S	S	S	S
OOCoD: Temporary upgrade						
Ability to replenish an ordered record	S	S	S	S	S	S
Administrative OOCoD testing	S	S	S	S	S	S
API for OOCoD activation	S	S	S	S	S	S
Automatic deactivation at expiration date	S	S	S	S	S	S
Automatic renewal to extend expiration date	O	O	O	O	O	O

On-demand function	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
CPs, IFL processors, ICF processors, IBM Z Integrated Information Processors (zIIPs), and System Assistance Processors (SAPs)	O	O	O	O	O	O
OOCoD test	S	S	S	S	S	S
OOCoD with extended staging	O	O	O	O	O	O
Post-paid upgrades with spending limits controlled by tokens ^f	O	O	O	O	O	O
Pre-paid upgrades controlled by tokens ^g	O	O	O	O	O	O
Replenishment and Reuse record	S	S	S	S	S	S
Subcapacity engine support	S	O	S	S	S	S
Uninstalled LICCC records can be staged on the SE	O	O	O	O	O	O
System Recovery Boost Upgrade (temporary records and pre-paid)						
System Recovery Boost Upgrade - zIIP records for temporary capacity boost	O	O	O	n	n	n
Tailored Fit Pricing for IBM Z® hardware						
Tailored Fit Pricing for IBM Z - Hardware Consumption solution	O	O	O	O	n	n
Ability to select the contract length (1 - 5 years)	S	S	S	S	n	n
Flexible Capacity for cyber resilience						
Flexible Capacity for cyber resilience ^h	O	O	n	n	n	n

- a. Memory upgrades are concurrent only if there is enough physical memory that is installed (LICCC upgrades only). The maximum physical memory that is installed depends on the CPC drawer feature.
- b. Concurrent processor upgrades are possible only if there are installed but not active processors available (LICCC upgrades only). The maximum number of processors that is installed depends on the CPC drawer feature.
- c. IBM z16 A01 Concurrent CPC Drawer is restricted going from 1-> 2 drawers and from 2 -> 3 drawers. (4-CPC drawer machines are factory only).
- d. With IBM z16 A02 and IBM z16 AGZ Max32 with the plan-ahead feature, a second CPC drawer may be added concurrently when upgrading to a Max68.
- e. With IBM z16 A01, CPE has been replaced by Flex Capacity. CPE can be carried forward but cannot be ordered for IBM z16 A01. CPE is not supported on IBM z16 A02 and IBM z16 AGZ.
- f. Post-paid; Requires contract. CP only
- g. Pre-paid; Requires contract. CP only.
- h. Production capacity shift cross-site between IBM z16 machines for disaster recovery (DR) test, planned maintenance, proactive outage avoidance, and actual DR scenarios.

IBM Parallel Sysplex

IBM Parallel Sysplex® is a clustering technology that you can use to operate and manage up to 32 z/OS systems as a single system image (SSI) from a single point of control. The underlying structure of the Parallel Sysplex remains transparent to users, networks, applications, and operations.

To realize these benefits, z/OS Parallel Sysplex combines two critical capabilities: Parallel processing, and enabling read/write data sharing across multiple systems with full data integrity. This combination makes z/OS Parallel Sysplex unique from every other system, solution, and architecture that is available today.

Parallel Sysplex CF levels, connectivity features, and Server Time Protocol (STP) functions are listed in Table 16.

Table 16 Parallel Sysplex CF levels, connectivity features, and STP functions

Parallel Sysplex	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
CFLevel=25 ^a	S	S	n	n	n	n
Structure Full Recovery	S	S	n	n	n	n
Cache and Lock structures retry enhancements	S	S	n	n	n	n
Additional Cache Structure Metrics	S	S	n	n	n	n
CF Support for 224 tasks	S	S	n	n	n	n
CFLevel=24	n	n	S	S	n	n
CFCC Fair Latch Manager	S	S	S	S	n	n
CFCC Message Path Resilience enhancement	S	S	S	S	n	n
CF Monopolization Avoidance	S	S	S	S	n	n
CFLevel=23	n	n	n	n	S ^b	S
CFLevel=22	n	n	n	n	S	S
System-managed CF structure duplexing	S	S	S	S	S	S
Coupling Facility dynamic dispatch ON/OFF	n	n	S	S	S	S
Coupling Facility Thin Interrupt	S	S	S	S	S	S
Coupling facility shared processors	S	S	S	S	S	S
ICF	O	O	O	O	O	O
z/VM guest coupling	S	S	S	S	S	S

Parallel Sysplex	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
Coupling Links features for Parallel Sysplex clustering						
Integrated Coupling Adapter (ICA SR1.1) (two port and eight CHPIDs) Feature Code 0176	O	O	O	O	n	n
Integrated Coupling Adapter (ICA SR) (two ports and eight CHPIDs) Feature Code 0172	CF	CF	CF	CF	O	O
Coupling Express2 LR - (two ports and eight CHPIDs) Feature Code 0434	O	O	n	n	n	n
Coupling Express Long Reach (two ports and 8 CHPIDs) Feature Code 0433	n	n	O	O	O	O
Internal Coupling (IC) link ^c	S	S	S	S	S	S
HCA3-O LR fanout for 1xIFB (four ports and 16 CHPIDs) Feature Code 0170	n	n	n	n	O	n
HCA3-O fanout for 12x IFB (two ports and 8 CHPIDs) Feature Code 0171	n	n	n	n	O	n
Server Time Protocol (STP)^d						
External Time Source direct Ethernet connectivity to platform (Network Time Protocol (NTP) and Precision Time Protocol (PTP))	S ^e	S ^e	n	n	n	n
Graphical setup and configuration at the HMC	S ^e	S ^e	S ^f	S ^g	S	S
Coordinated Timing Network (CTN) Dynamic Split or Merge ^g	S	S	S	S	S	S
Additional stratum level (4)	S	S	S	S	S	S
Continuous availability of NTP servers	S	S	S	S	S	S
HMC used as an NTP server ^h	S	S	S	S	S	S
NTP server with pulse per second (PPS) ⁱ	S	S	S	S	S	S
NTP client	S	S	S	S	S	S
IEEE 1588 PTP support as External Time Source ^j	S	S	S ^k	S ^l	n	n
PTP server with pulse per second (PPS)	S	S	S	S	n	n
Improved STP recovery and availability when an Internal Battery Feature (IBF) is installed on one or more servers in the CTN	na ^m	na ^m	S	na ⁿ	S	na ⁿ
Going away signal to improve recovery	S	S	S	S	S	S
Sysplex Time with PTP direct to CPC	O	O	n	n	n	n
n-mode Power STP imminent Disruption signal ⁿ	S	S	n	n	n	n
Enhanced Console Assisted Recovery	S	S	S	S	S	S

Parallel Sysplex	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
Save STP configuration and time information across power-on resets (PORs) or power outages for a single or dual-server STP-only CTN	S	S	S	S	S	S
z/OS messaging when events occur related to accessing an ETS	S	S	S	S	S	S

- a. Enhancements for CFCC Level 25. CFCC Level 25 includes enhancements from previous CFCC levels. Require OS support.
- b. CFCC Level 23 was delivered with IBM z14 Driver Level 36.
- c. 64 per CPC for IBM z16™ and IBM z15, up from 32 per CPC for previous generations. Total Coupling CHPIDs that are allowed are 384 for IBM z15 and IBM z16, and 256 for earlier servers.
- d. The STP feature is optional and does not need to be in a sysplex environment.
- e. Setting up STP for IBM z16 requires HMC 2.16.0.
- f. Setting up STP for IBM z15 requires HMC 2.15.0 or later. The SE (Driver 41) Sysplex Timer task has been discontinued.
- g. Requires HMC 2.14.1 or later.
- h. The HMC must be at level 2.10.1 for an STP-only CTN to obtain its external time. This feature is not available when the HMC is used as NTP server.
- i. Not available when the HMC is used as NTP server.
- j. Requires a PTP-capable infrastructure (including networking support). Requires PPS.
- k. For IBM z15, PTP Server connectivity is provided through an SE management network connection.
- l. Available only if PTS or Current Time Server (CTS) and Backup Time Server (BTS) are IBM z16 CPCs. Other CPCs in the Timing Network (including Arbiter) can be a mix of IBM z16 or legacy CPCs.
- m. The IBF feature is not available for this CPC.
- n. Must be configured (opt-in). Requires that both PTS and BTS are on an IBM z16.

Performance

Workload capacity performance is sensitive to three major factors: Instruction path length, instruction complexity, and memory hierarchy.

IBM Z configurations are designed to deliver the highest levels of performance and capacity for large-scale consolidation and growth. Attributes and design points of the IBM Z platform that contribute to overall performance and throughput are listed in Table 17 on page 23.

Table 17 Performance

Performance	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
16 floating point registers	S	S	S	S	S	S
64-bit addressing	S	S	S	S	S	S
Branch and set authority facility	S	S	S	S	S	S
Compare and move extended facility	S	S	S	S	S	S
Data hardware compression (CMPSC)	S	S	S	S	S	S
IBM Integrated Accelerator for IBM zEnterprise® Data Compression Express (zEDC)	S	S	S	S	n	n
IBM Integrated Accelerator for IBM zSort	S	S	S	S	n	n
IBM Z Integrated Accelerator for AI	S	S	n	n	n	n
Dedicated move page engine	S	S	S	S	S	S
Dynamic CF dispatching	n ^a	n ^a	S	S	S	S
Dynamic Address Translation (DAT)	S	S	S	S	S	S
Enhanced Move Page for virtual machines (VMs)	S	S	S	S	S	S
Extended translation facility	S	S	S	S	S	S
Extensions for VMs	S	S	S	S	S	S
Flexible memory configurations ^b	O	n	O	n	O	n
Floating point instruction ^c	S	S	S	S	S	S
Hardware decimal floating point facility	S	S	S	S	S	S
Hexadecimal floating point (HFP) square root instruction ^c	S	S	S	S	S	S
HiperDispatch function	S	S	S	S	S	S
Immediate and relative instruction ^c	S	S	S	S	S	S
Large Page Support	S	S	S	S	S	S
1 MB large page support (pageable)	S	S	S	S	S	S
2 GB large page support	O	O	O	O	O	O
Level 1 cache size (Instruction and Data in KB)	128 128	128 128	128 128	128 128	128 128	128 128
Level 2 cache size (Instruction and Data in MB)	32 ^d	32 ^d	4/4	4/4	2/4	2/4
Level 3 cache size (in MB)	256 ^e	256 ^f	256	256	128	128
Level 4 cache size (in MB) ^g	2048 ^e	2048 ^h	960	960	672	672

Performance	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Logical string assist	S	S	S	S	S	S
Long displacement facility	S	S	S	S	S	S
Number of cores per processor unit ⁱ	8/16	8/16	12	12 ^j	10	10
Move page	S	S	S	S	S	S
Runtime Instrumentation	S	S	S	S	S	S
Out of Order Instruction Execution	S	S	S	S	S	S
Perform locked operation facility	S	S	S	S	S	S
Plan ahead memory	n	n	n	n	O	O
Processor frequency (Ghz)	5.2	4.6	5.2	4.5	5.2	4.5
Server/Application State Protocol (SASP) support for load-balancing across virtual servers	S	S	S	S	S	S
Start Interpretive Execution (SIE)	S	S	S	S	S	S
Superscalar	S	S	S	S	S	S
Suppression on protection facility	S	S	S	S	S	S
Simultaneous multithreading (SMT) on zIIPs, IFL processors, and SAPs	S	S	S	S	S	S
Single Instruction Multiple Data (SIMD)	S	S	S	S	S	S
System Recovery Boost ^k	S	S	S	S	n	n
z/OS recovery process boost ^l	S	S	S	S	n	n
System Recovery Boost Upgrade (Feature Code 6802)	O	O	O	n	n	n
zIIPs	O	O	O	O	O	O
Transactional Memory	S	S	S	S	S	S
Trimodal addressing (24-, 31-, and 64-bit addressing) support	S	S	S	S	S	S
zHyperLink support	S	S	S	S	S	S
Maximum supported memory (in TB) ^m	40	16 ⁿ	40	16	32	8
zEDC						
zEDC Feature Code 0420 ^o	n	n	n	n	O	O
On-chip IBM Integrated Accelerator for zEDC	S	S	S	S	n	n
On-core Sort Accelerator	S	S	S	S	n	n

Performance	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
On-core Integrated Accelerator for Artificial Intelligence (AIU)	S	S	n	n	n	n
Virtual Flash Memory (VFM)						
Virtual Flash Memory (VFM)	O	O	O	O	O	O

- a. Only **DYNDISP THIN** is supported on IBM z16. Coupling Facility Dynamic Dispatching ON/OFF is not supported on IBM z16, and if it is specified, a warning message indicates that the CF image will use **DYNDISP THIN** instead.
- b. Flexible Memory is an option for multi-drawer systems to alleviate memory requirements when a CPC drawer is replaced (concurrently).
- c. For more information, see *Principles of Operation, SA22-7832*.
- d. IBM z16 has a unified L2 cache, with 32 MB semi private to each core.
- e. Virtual L3 and L4 caches. For IBM z16, L3 and L4 caches are logical constructions.
- f. Virtual L3 and L4 caches. For IBM z16, L3 and L4 caches are logical constructions.
- g. At the CPC drawer level. A multiple-CPC system uses SMP connectivity for L4 cache coherency at the system level.
- h. IBM z16 A02 and the IBM z16 AGZ L4 cache sizes are 1024 MB for Max5 and Max16, and 2048 MB for Max32 and Max68.
- i. Eight cores per PU chip and 16 cores per (dual-chip module (DCM) maximum. The maximum number of cores is not available on all PUs chips or DCMs.
- j. Twelve cores by design with 7 - 11 active cores.
- k. Requires operating system opt-in. For more information, see *Introducing IBM Z System Recovery Boost, REDP-5563*.
- l. A short duration boost for speeding up sysplex recovery that is based on the System Recovery Boost function. Requires operating system opt-in. Applicable to three z/OS oriented uses cases: SVC dump processing, client-selected middleware starts and restarts, and IBM HyperSwap® configurations load and reload.
- m. The maximum amount of memory depends on the system configuration and the number of CPC drawers.
- n. The maximum memory is 8 TB for one CPC drawer and 16 TB for two CPC drawers.
- o. For the IBM z16 server generation (M/T 3931 and M/T 3832) and for the IBM z15 server generation (M/T 8561 and 8562), Feature Code 0420 PCIe Feature (zEDC) has been replaced by the on-chip IBM Integrated Accelerator for zEnterprise Data Compression.

Processor Resource/Systems Manager

IBM Processor Resource/Systems Manager (PR/SM) consists of hardware and microcode that is built into the IBM Z platform to support the sharing of available hardware resources in logical partitions (LPARs). With LPARs, you can run multiple system images on a single CPC. Each image includes a full complement of CPUs (dedicated or shared), memory, and channels (for storage and network connectivity). Channels can be shared across images by using the MIF feature.

The PR/SM function ensures the highest level of optimized resources usage (near to 100%). The main characteristics of PR/SM are listed in Table 18.

Table 18 PR/SM characteristics

PR/SM characteristics	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
128-bit time of day (TOD) clock (Extended TOD clock facility) ^a	S	S	S	S	S	S
Absolute capping support of PUs (all types)	S	S	S	S	S	S
Absolute capping support of an LPAR group	S	S	S	S	S	S
Add or delete an LPAR name	S	S	S	S	S	S
Automatic Reconfiguration Facility (ARF)	S	S	S	S	S	S
Defined capacity I/O	S	S	S	S	S	S
Dynamic Memory Management	S	S	S	S	S	S
Dynamic Storage Reconfiguration	S	S	S	S	S	S
Dynamic PU reassignment	S	S	S	S	S	S
EAL5 certification	S	S	S	S	S	S
Hardware system area (HSA) size (in GB)	256	160	256	160	192	64
Hypervisor support for virtualization: z/VM	S	S	S	S	S	S
Hypervisor support for virtualization: KVM	S	S	S	S	S	S
Individual management of PU types	S	S	S	S	S	S
LPAR time offset	S	S	S	S	S	S
LPAR group capacity limit	S	S	S	S	S	S
LPAR management time report	S	S	S	S	S	S
LPAR preferred path	S	S	S	S	S	S
Maximum number of configurable processors	200	68	190	65	170	30
Maximum number of CPs	200	6 ^b	190	6	170	6
Maximum number of supported LPARs	85	40	85	40	85	40
Maximum number of supported LCSS	6	3	6	3	6	3
Maximum number of subchannel sets per LCSS	4	3	4	3	4	3
SMT for IFL processors, zIIPs, and SAPs	S	S	S	S	S	S
SIMD	S	S	S	S	S	S
Single storage pool	S	S	S	S	S	S
SSC	S	S	S	S	S	S
Secure Execution for Linux ^c	S	S	S	S	n	n

PR/SM characteristics	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0X	IBM z14 ZR1
Dynamic Partition Manager (DPM)	O	O	O	O	O	O
Intelligent Resource Directory (IRD)						
CSS priority queuing	S	S	S	S	S	S
Dynamic Channel Path Management (DCMs)	S	S	S	S	S	S
LPAR CPU management	S	S	S	S	S	S
Processor types						
CP	O	O	O	O	O	O
SAP ^d	S,O	S	S,O	S,O	S,O	S,O
ICF	O	O	O	O	O	O
IFL	O	O	O	O	O	O
IFP ^e	S	S	S	S	S	S
zIIP	O	O	O	O	O	O

a. The Extended-TOD-Clock Facility is a hardware facility that provides a 128-bit TOD clock.

b. For Max5, the maximum number of CPs is five.

c. Secure Execution for Linux for second-level Linux guests (Feature Code 0115).

d. SAPs are standard. The initial number of SAPs is model-dependent. Additional (optional)

SAPs can be added through Feature Code 1963 on IBM z16 A01, Feature Code 1949 on

IBM z15, and Feature Code 1935 on IBM z14. IBM z16 A02 and IBM z16 AGZ do not support additional SAPs.

e. IFPs are standard and not defined by the customer. IFPs are used for infrastructure management.

Reliability, availability, and serviceability

The IBM Z design is focused on providing higher availability by reducing planned and unplanned outages, which is commonly known as *reliability, availability, and serviceability* (RAS). RAS can be accomplished by using improved concurrent replace, repair, and upgrade functions for processors, memory, and I/O. RAS also extends to the non-disruptive capability for installing LIC updates.

As an extension to the RAS capabilities, environmental controls are implemented in the system to help reduce power consumption and meet cooling requirements. Continuous improvements in RAS are associated with new features and functions to ensure that the IBM Z platform delivers exceptional value.

The main RAS features of IBM z16, IBM z15, and IBM z14 are listed in Table 19.

Table 19 RAS features

RAS	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
50/60 Hz power	S	S	S	S	S	S
Three-phase AC power	S	S	S	O	S	n
DC power	n	n	n	n	O	n
Ability to display and track historical power, temperature, and utilization data	S	S	S	S	S	S
Alternative HMC ^a	O	O	O	O	O	O
Alternative SE	S	S	S	O	S	S
Hardware Management Appliance (HMA)	O	S	O ^b	O	n	n
Remote Code Load	S	S	n	n	n	n
Bolt-down kit for low-raised floor and high-raised floor installation ^c	O	O ^d	O	O	O	O
Bolt-down kit for non-raised floor installation ^c	O	O ^d	O	O	O	O
Concurrent channel adapter add	S	S	S	S	S	S
Concurrent book or processor drawer add	S ^e	S ^f	S ^e	n	S	n
Concurrent PCIe+ I/O drawer add	S ^g	S ^g	S ^g	S ^g	S	S ^g
Dynamic Fabric repair	S	S	S	S	S	S
Concurrent PU conversions	O	O	O	O	O	O
Console Integration (CI)	S	S	S	S	S	S
Digitally signed firmware that is provided by the HMC and SE	S	S	S	S	S	S
Dynamic change to partition a cryptographic coprocessor configuration	S	S	S	S	S	S
Dynamic add of a logical processor to an LPAR	S	S	S	S	S	S
Dynamic LCSS add without planning	S	S	S	S	S	S
Dynamic memory bit lane sparing	S	S	S	S	S	S
Dynamic memory sparing ^h	S	S	S	S	S	S
Dynamic oscillator switchover	S	S	S	S	S	S
Dynamic partition add without planning	S	S	S	S	S	S
Dynamic subchannel set add without planning	S	S	S	S	S	S
Enhanced application preservation	S	S	S	S	S	S

RAS	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Enhanced drawer availability (EDA) for a processor drawer ⁱ	S	S	S	S	S	n
Two DCMs on a 3932 Max5	n	S	n	n	n	n
Fault-tolerant design	S	S	S	S	S	S
FCP program directed IPL	O	S	O	O	O	O
IBM FICON channel link error problem analysis	S	S	S	S	S	S
FIDR	S	S	S	S	S	S
FICON forward error correction (FEC) for FICON ^j	S	S	S	S	S	S
FICON link incident reporting	O	S	O	S	O	O
FICON SAN Fabric I/O Priority for Workload Manager (WLM)	S	S	S	S	S	S
FICON multihop cascaded directors (maximum number of directors)	4	4	4	4	4	4
Fixed HSA	S	S	S	S	S	S
HMC and SE IPv6 support	S	S	S	S	S	S
HMC FCP Problem Determination panels	S	S	S	S	S	S
HMC instant messenger	S	S	S	S	S	S
I/O interface reset	S	S	S	S	S	S
IBF ^k	n	n	O	n	O	n
IPL from alternative subchannel set	S	S	S	S	S	S
LICCC memory upgrade	S	S	S	S	S	S
LICCC processor upgrade	S	S	S	S	S	S
Memory RAIM	S	S	S	S	S	S
Monitor and track power consumption, internal temperature, and utilization data of the CPC by using the monitor dashboard task on the HMC	S	S	S	S	S	S
Multipath IPL - with z/OS	S	S	S	S	S	S
Nondisruptive I/O removal	S	S	S	S	S	S
N+1 power supplies	S	S	S	S	S	S
Partial CP restart	S	S	S	S	S	S
Partial memory restart	S	S	S	S	S	S
Power distribution union (PDU) power option	O	O ^l	O	S	n	S
Bulk Power Assembly (BPA) power option	O	na	O	na	S	na

RAS	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
Balanced Power - Plan ahead (BPA models only)	O	na	O	na	O	na
Power - dual power feeds	S	S	S	S	S	S
Power - Plan ahead power cords ^m	O	O	O	n	O	n
Power consumption estimator tool (IBM Resource Link)	S	S	S	S	S	S
Manage Power Service State (HMC) - (CPC power redundancy check)	S	S	S	S	S	S
Precheck function to detect conflicts between a new permanent upgrade and any active temporary resources	S	S	S	S	S	S
Processor drawer degradation mode	S	S	S	S	S	S
PU sparing (if a spare is available, which is config dependent)	S	S	S	S	S	S
SAP reassignment	S	S	S	S	S	S
Sparing for storage protect keys	S	S	S	S	S	S
Subspace group facility	S	S	S	S	S	S
Subsystems storage protect	S	S	S	S	S	S
Symbol Error Correction Code (ECC) on L2, L3, and L4 cache	S ⁿ	S ⁿ	S	S	S	S
System-initiated CHPID reconfiguration	S	S	S	S	S	S
Top exit I/O cabling	O	O	O	O	O	O
Top exit power cabling	O	O	O	O	O	O
Water manifold for processor cooling as a field-replaceable unit (FRU)	S	n	S	n	S	n
WWPN tool to help with planning and setting up a SAN environment before installation	S	S	S	S	S	S
Concurrent maintenance						
Channel - Adapter	S	S	S	S	S	S
Cooling units (water-cooled) ^o Water Cooling Unit (WCU)	n	n	S	n	S	n
Cooling units (air cooled) ^p Radiator Cooling Unit (RCU)	S	n	S	n	S	n
CPC drawer (including memory DIMMs) ⁱ	S	S	S	S	S	n
Enhanced driver maintenance	S	S	S	S	S	S
HMC	S	S	S	S	S	S

RAS	IBM z16 A01	IBM z16 A02 IBM z16 AGZ	IBM z15 T01	IBM z15 T02	IBM z14 M0x	IBM z14 ZR1
IFB-MP	na	na	na	na	O ^q	n
Oscillator	S	S	S	S	S	S
PCIe I/O drawer or PCIe+ I/O drawer ^d	S	S	S	S	S	S
PCI-IN	S	S	S	S	S	S
Point of Load (POL) - CPC drawer power regulators ^r	S	S	S	S	S	S
Single-Chip Module (SCM)	na	na	S	S	S	S
Dual Chip Module (DCM)	S	S	na	na	na	na
SE	S	S	S	S	S	S
Concurrent MCL apply						
CFCC ^s	S	S	S	S	S	S
Channel features						
CE LR ^t	n	n	S	S	S	S
CE2 LR ^t	S	S	na	na	na	na
RoCE Express ^t	S	S	S	S	S	S
Crypto-Express ^t	S	S	S	S	S	S
FICON-Express	S	S	S	S	S	S
IC	S	S	S	S	S	S
ICA SR	S	S	S	S	S	S
HCA3 features	na	na	na	na	S	na
OSA-Express	S	S	S	S	S	S
zHyperLink ^{t,q}	S	S	S	S	S	S
HMC	S	S	S	S	S	S
SE	S	S	S	S	S	S
PU core engineering data	S	S	S	S	S	S

- a. With HMA (Feature Code 0129), two HMCs are always available.
- b. HMC running on the SE hardware. Available with an initial order only (no MES).
- c. This feature applies to a raised-floor environment. This feature supplies the kit of parts that are designed to help secure the frames and their contents from damage when exposed to vibrations and shocks, such as in a seismic event.
- d. The rack or cabinet may be securely bolted to the floor, ceiling, or walls, or to adjacent racks or cabinets in a long and heavy row of racks or cabinets.
- e. On IBM z16 A01, a field addition (MES) of the fourth CPC drawer is not supported (upgrades from IBM z16 A01 Max39 to Max82 or Max125 only). For IBM z15 T01, a field addition of fourth or fifth CPC drawers is not supported (upgrades from IBM z15 T02 Max31 to Max65 or Max108 only). A CPC reserve feature must be present in the initial order for supported upgrades.

- f. With the plan-ahead feature, a second drawer may be concurrently added to IBM z16 A02 and IBM z16 AGZ when upgrading to a Max68.
- g. IBM z16, IBM z15, and IBM z14 ZR1 are housed in a an industry standard, 19-inch format frame. A new PCIe+ I/O drawer (capable of hosting up to 16 PCIe features) was designed and built to fit the 19-inch rack. IBM z16, IBM z15 and IBM z14 ZR1 do not support a PCIe I/O drawer (capable of hosting 32 PCIe features). Adding a PCIe+ I/O drawer is concurrent.
- h. Sparing can be done with steering or marking technology.
- i. Applies to systems with two or more processor drawers.
- j. All FICON features that are newer than FICON EXPRESS16S have FICON Error Correction (FEC) implemented.
- k. The IFB feature is excluded from a sysplex or CTN when an IBM z16 server is part of the configuration.
- l. IBM z16 A02 is powered by IBM Z intelligent power distribution units (iPDUs).
IBM z16 AGZ is powered by the client's provided PDUs. (IBM Z firmware has no control over or communication with the client PDUs).
- m. Available for BPA models only.
- n. For IBM z16, L3 and L4 levels are implemented as virtual shared victim cache.
- o. IBM z15 T01 and IBM z14 M0X only. WCU is not offered for IBM z16.
- p. Exchanging the RCU is not concurrent. Within the RCU, The Radiator Pump Unit (RPU) and the Cooling Fan Assembly (CFA) are concurrent-replaceable.
- q. zHyperlink works with an existing FICON SAN infrastructure.
- r. Point Of Load (POL) is a CPC drawer power distribution system. Replacement is concurrent for models with two or more CPC drawers.
- s. A CF partition restart might be required.
- t. Require planning for maintenance and redundant adapters.

IBM Z Platform Certifications

The table below shows the IBM Z Platform Certifications obtained from these independent Certification Authorities:

- ▶ BSI ([Bundesamt für Sicherheit in der Informationstechnik](#)) in Germany
- ▶ NIAP-CCEVS ([CC Evaluation and Validation Scheme](#)) in the U.S
- ▶ OCSI ([Organismo di Certificazione della Sicurezza Informatica](#)) in Italy
- ▶ NIST ([National Institute of Standards and Technology](#)) in the U.S.

The links inside the table will open the sites where the certificates reside and can be downloaded from. It is important to mention that the certifications, in general, are obtained sometime after the IBM Z product general availability.

IBM Z Certifications	IBM z16 (Driver 51C Bundle 4B)	IBM z15 (Driver 41C Bundle S21b)	IBM z14 (Driver 32L Bundle S35)
All the IBM Z models are designed for Common Criteria Evaluation Assurance Level 5+ (EAL5+) certification for security of logical partitions. This means that the IBM Z is designed to prevent an application running on one operating system image on one LPAR from accessing application data running on a different operating system image on another LPAR on the server.	BSI-DSZ-CC-1186-2023	BSI-DSZ-CC-1133-2020 and BSI-DSZ-CC-1160-2021	BSI-DSZ-CC-1048-2018 and BSI-DSZ-CC-1101-2019
z/VM 7.2 Evaluation Assurance Level 4 (EAL4+).		Certificate	
z/VM 7.2 System SSL Module has been validated as conforming to the Federal Information Processing Standard (FIPS) 140-2.		Certificate	
z/VM 6.4 Common Criteria standard for IT security, ISO/IEC 15408, at EAL4+.		Certificate	
z/VM 6.3 Evaluation Assurance Level 4+.			BSI-DSZ-CC-0903-2015
Linux^a Red Hat Enterprise Linux Version 7.1			BSI-DSZ-CC-0999-2016
Linux^a SUSE Linux Enterprise Server Version 12			BSI-DSZ-CC-0962-2016
Crypto 8S (CEX8S) 4770 FIPS 140-2 Level 4 PCI HSM	Certificate number 4558 PCI PTS Website^b		
Crypto7S (CEX7S) 4769 FIPS 140-2 Level 4 PCI HSM		Certificate number 4079 PCI PTS Website^b	

IBM Z Certifications	IBM z16 (Driver 51C Bundle 4B)	IBM z15 (Driver 41C Bundle S21b)	IBM z14 (Driver 32L Bundle S35)
Crypto6S (CEX6S) 4768 FIPS 140-2 Level 4 PCI HSM			Certificate number 3410 PCI PTS Website^b

a. Evaluated at an approved evaluation facility using the Common Methodology for IT Security Evaluation (CEM), Version 3.1 for conformance to the Common Criteria for IT Security Evaluation (CC), Version 3.1. The evaluation achieved an Evaluated Assurance Level 4+, augmented with ALC_FLR.3.

b. Once the PCI link opens, enter the Crypto xS number (4768,4769 or 4770) in the search field and press enter.

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Thanks to the following people for their contributions to this project:

Ron Geiger, Frank J Miele, David Surman
IBM Poughkeepsie

Christine Smith
IBM Endicott

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REDP-5157-07

ISBN 0738461105

Printed in U.S.A.

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