z/VM
7.4

General Information

GC24-6286-74

Note:

Before you use this information and the product it supports, read the information in “Notices” on page 117.

This edition applies to version 7, release 4 of IBM® z/VM® (product number 5741-A09) and to all subsequent releases and modifications until otherwise indicated in new editions.

Last updated: 2025-09-29

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About this document

This document provides the following information about the IBM z/VM licensed program:

- Product overview
- What is new or changed in z/VM 7.4
- Hardware and software requirements
- Guide to the product documentation
- IBM servers, guest operating systems, and devices supported by current z/VM releases

Intended audience

This information is intended for anyone who wants a general overview of z/VM. It is also useful for those who need to evaluate the capabilities of z/VM and determine the resources necessary to install and run it.

Where to find more information

You can obtain more information about z/VM from the documents described in Chapter 6, "z/VM library guide," on page 69.

Links to other documents and websites

The PDF version of this document contains links to other documents and websites. A link from this document to another document works only when both documents are in the same directory or database, and a link to a website works only if you have access to the Internet. A document link is to a specific edition. If a new edition of a linked document has been published since the publication of this document, the linked document might not be the latest edition.

How to provide feedback to IBM

We welcome any feedback that you have, including comments on the clarity, accuracy, or completeness of the information. See How to send feedback to IBM for additional information.

Summary of changes for z/VM: General Information

This information includes terminology, maintenance, and editorial changes. Technical changes or additions to the text and illustrations for the current edition are indicated by a vertical line (|) to the left of the change.

While IBM values the use of inclusive language, terms that are outside of IBM's direct influence, for the sake of maintaining user understanding, are sometimes required. As other industry leaders join IBM in embracing the use of inclusive language, IBM will continue to update the documentation.

GC24-6286-74, z/VM 7.4 (September 2025)

This edition includes updates to support the following z/VM 7.4 New Function APARs:

- **Support and exploitation of hardware and architectures, and hypervisor efficiency and scalability**
  - "[7.4, 7.3 APARs] Enhanced QDIO virtual switch vNIC simulation" on page 16
  - "[7.4, 7.3 APARs] Transactional execution disablement" on page 16
- **System administration, operation, and ease of use**
  - "[7.4 APAR] Unified DIFF and PATCH support for CMS" on page 19
  - "[7.4 APAR] Fast LOGOFF control" on page 19
- **Security**
  - "RACF utility enhancements" on page 19
- **Application development and deployment**
  - "[7.4 APAR] DirMaint and SMAPI LOADDEV ALTERNATE directory support" on page 19
  - "[7.4 APAR] SMAPI support for querying linear service" on page 20
- **System diagnosis**
  - "[7.4 APAR] Soft abend improvements" on page 20

The following topics are also updated:

- "[7.4, 7.3 APARs] Single system image (SSI) prerequisite support for future-server compatibility" on page 14
- "[7.4, 7.3 APARs] z/VM support for the IBM z17 family" on page 14
- "[7.4, 7.3 APARs] z/VM TCP/IP support for enhanced QDIO" on page 17
- "Server features and miscellaneous devices" on page 103

For a list of all of the z/VM 7.4 New Function APARs, see Chapter 2, "What is new or changed in z/VM 7.4," on page 9.

GC24-6286-74, z/VM 7.4 (July 2025)

This edition includes changes to support product changes that are provided or announced after the general availability of z/VM 7.3 and 7.4.

The following topics are updated:

- Chapter 2, "What is new or changed in z/VM 7.4," on page 9
- **Support and exploitation of hardware and architectures, and hypervisor efficiency and scalability**
  - "[7.4, 7.3 APARs] z/VM support for the IBM z17 family" on page 14
- **System administration, operation, and ease of use**

  - "[7.4, 7.3 APARs] z/VM Performance Data Pump enhancements" on page 18
- "Server support: IBM z17 family" on page 87
- "Other limits" on page 115

For a list of all of the z/VM 7.4 New Function APARs, see Chapter 2, "What is new or changed in z/VM 7.4," on page 9.

GC24-6286-74, z/VM 7.4 (June 2025)

This edition includes updates to support the following z/VM 7.4 and 7.3 New Function APARs:

- **Installation, migration, and service**
  - "[7.4 APAR] z/VM linear service environment variables" on page 13
- **Support and exploitation of hardware and architectures, and hypervisor efficiency and scalability**
  - "[7.4, 7.3 APARs] Single system image (SSI) prerequisite support for future-server compatibility" on page 14
  - "[7.4, 7.3 APARs] z/VM support for the IBM z17 family" on page 14
- **Connectivity and networking**
  - "[7.4, 7.3 APARs] z/VM TCP/IP support for enhanced QDIO" on page 17
- **System administration, operation, and ease of use**
  - "[7.4, 7.3 APARs] SMAPI support for enhanced QDIO" on page 18
  - "[7.4, 7.3 APARs] z/VM Performance Data Pump enhancements" on page 18

For a list of all of the z/VM 7.4 New Function APARs, see Chapter 2, "What is new or changed in z/VM 7.4," on page 9.

GC24-6286-74, z/VM 7.4 (March 2025)

This edition includes updates to support the following z/VM 7.4 New Function APARs:

- **Installation, migration, and service**
  - "[7.4 APAR] GETSHOPZ ServiceLink support" on page 13
- **Support and exploitation of hardware and architectures, and hypervisor efficiency and scalability**
  - "[7.4 APAR] TRSOURCE support for five-digit real device addresses" on page 13
- **System administration, operation, and ease of use**
  - "[7.4 APAR] Two-speed Monitor sampling" on page 18

Updates are also listed in Chapter 2, "What is new or changed in z/VM 7.4," on page 9.

GC24-6286-74, z/VM 7.4 (September 2024)

This edition supports the general availability of z/VM 7.4. Note that the publication number suffix (-74) indicates the z/VM release to which this edition applies.

- **Product packaging**
  - "[7.4] Integration of HCD and HCM for z/VM into the CP component base" on page 11
  - "[7.4] Removal of physical DVDs as a product distribution medium" on page 11
  - "[7.4] Discontinuance of support for EREP VM 3" on page 12
- **Installation, migration, and service**
  - "[7.4] Installation changes" on page 12
  - "[7.4] Linear service" on page 12

Updates are also listed in Chapter 2, "What is new or changed in z/VM 7.4," on page 9.

Chapter 1. z/VM overview

z/VM provides IBM clients with a premier hypervisor for their existing workloads while also providing support for a modernization journey to hybrid cloud, hosting enterprise-class virtual servers to exploit the IBM Z® and IBM LinuxONE advantages in scalability, performance, high availability, and security.

z/VM virtualization technology is designed to run hundreds to thousands of guest servers on a single IBM Z server (where guests may include Linux® and others) or IBM LinuxONE server (where only Linux and z/VM guests are supported), with the highest degrees of efficiency and elasticity.

The ability of z/VM to support multiple machine images and architectures provides a highly flexible production and test environment for IBM Z and LinuxONE operating systems to:

- Simplify migration from one release to another
- Facilitate the transition to newer applications
- Provide a test environment whenever one is needed
- Consolidate many systems onto one physical server

A fundamental strength of z/VM is the ability for virtual machines to share system resources with very high levels of resource utilization. z/VM provides extreme scalability, security, and efficiency to create opportunities for cost savings, while providing a robust foundation for cognitive computing on the IBM Z and LinuxONE platforms.

z/VM provides support for IBM Z and LinuxONE servers, as well as Red Hat®, SUSE, and Ubuntu Linux distributions. Support for simultaneous multithreading (SMT) technology extends per-processor, core capacity growth beyond single-thread performance for Linux on IBM Z running on an IBM Integrated Facility for Linux (IFL) specialty engine on an IBM Z or LinuxONE server. z/VM multithreading technology support, along with 4TB real memory support, can enable additional price/performance benefits over previous hardware generations and can meet workload requirements transparently. Improvements made in the areas of reliability, availability, and serviceability allow low-end devices such as IBM Storwize® V7000, V840, and V9000 to be attached to a z/VM host, removing the need for a SAN Volume Controller.

z/VM is supported within the platform management simplification environment provided by the IBM Dynamic Partition Manager for Linux-only systems. This includes configuration management support for SCSI and ECKD storage. Starting with driver D51C bundle 28 for the IBM z16® family server, DPM management support is provided for Ficon Channel-to-Channel within the same CPC, allowing a DPM-managed system to configure a z/VM SSI cluster within the same IBM z16 family server. This simplifies system administration tasks, providing a more positive experience, especially for those with limited mainframe skills.

z/VM can help you extend the business value of IBM Z and LinuxONE technology across the enterprise by integrating applications and data, while providing exceptional levels of availability, security, and operational ease. World-class virtualization technology offered by z/VM can provide the ability to host a large number of virtual servers running different operating systems on IBM Z servers or a large number of virtual Linux servers on LinuxONE servers.

While cloud computing has become the standard use model for IT services, an IT infrastructure continues to be the foundation for every IT service. Realizing the benefits of cloud computing requires an infrastructure that delivers availability, reliability, security, and performance, while also providing strong virtualization technology, such as z/VM.

Virtualization is fundamental to delivering infrastructure as a service (IaaS), the basic building block for cloud. IBM continues to invest in z/VM technology to provide leading-edge virtualization capabilities for enterprises using IBM Z and IBM LinuxONE platforms. This can meet the needs of IT organizations to deliver the foundation for user satisfaction with various types of workloads:

- Cloud-native workloads based on Red Hat OpenShift® Container Platform and IBM Cloud® Paks or other container technologies

- Noncontainerized workloads—deployed using cloud and traditional operations models—from IBM, such as IBM WebSphere®, open source such as MongoDB, or software from ISVs.

IBM Cloud Infrastructure Center

IBM Cloud Infrastructure Center is an infrastructure management offering, built on OpenStack compatible APIs, that provides on-premises cloud deployments of z/VM Linux virtual machines on the IBM Z and LinuxONE platforms and the integration to higher-level cloud automation tools, such as IBM Cloud Automation Manager or VMware vRealize Automation and vRealize Orchestrator.

IBM Cloud Infrastructure Center provides a consistent, industry-standard user experience to define, instantiate, and manage the lifecycle of virtual infrastructure, deployment of images (operating system and applications), and policies to maximize resource utilization. It is built to require no specific platform skills from the user and minimal platform skills from the administrator to accelerate cloud deployments.

z/VM, together with IBM Cloud Infrastructure Center, which helps manage the lifecycle of virtual infrastructure, provides a foundation for private cloud on an IBM Z and IBM LinuxONE server as part of a hybrid cloud approach.

For additional information, see IBM Cloud Infrastructure Center (https://www.ibm.com/products/cloud-infrastructure-center).

z/VM components, facilities, and optional features

The z/VM base product includes the following components and facilities:

Control Program (CP)
CP is a hypervisor and real-machine resource manager. It includes the single system image (SSI) function, which enables up to four z/VM systems to share and coordinate resources within a single SSI cluster.

Advanced Program-to-Program Communication/Virtual Machine (APPC/VM) Virtual Telecommunications Access Method (VTAM®) Support (AVS)
AVS provides connectivity in an IBM Systems Network Architecture (SNA) network.

Conversational Monitor System (CMS)
CMS provides a high-capacity application and interactive user environment and provides the z/VM file systems.

Dump Viewing Facility
Dump Viewing Facility is a tool that analyzes and manages system software problems interactively under CMS. (CP problems are handled by the VM Dump Tool function of CP.)

Group Control System (GCS)
GCS is a virtual machine supervisor that provides multitasking services and supports a native SNA network.

Hardware Configuration Definition (HCD) and Hardware Configuration Manager (HCM) for z/VM
HCD and HCM provide a comprehensive I/O configuration management environment.

Language Environment® for z/VM
Language Environment provides the runtime environment for z/VM application programs written in C®/C++, COBOL, or PL/I.

REXX/VM
REXX/VM contains the interpreter for processing the REXX programming language.

TCP/IP for z/VM
TCP/IP for z/VM provides support for the TCP/IP networking environment.

Transparent Services Access Facility (TSAF)
TSAF provides communication services within a collection of z/VM systems without requiring VTAM.

Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E)
VMSES/E provides a tools suite for installing and servicing z/VM and other enabled products.

For more information about these components and facilities, see Chapter 4, “z/VM base product,” on page 41.

z/VM also offers the following optional features:

Data Facility Storage Management Subsystem for z/VM (DFSMS/VM)
DFSMS/VM controls data and storage resources and provides an interface for tape librarian products to an Automated Tape Library.

Directory Maintenance Facility for z/VM (DirMaint)
DirMaint provides interactive facilities for managing the z/VM user directory.

Performance Toolkit for z/VM
Performance Toolkit provides tools for analyzing z/VM and Linux performance data.

z/VM Performance Data Pump (Data Pump) is included with the Performance Toolkit for z/VM license. Data Pump converts machine-readable z/VM monitor and SFS data into a generic text-based data stream for display in modern enterprise observability solutions.

Remote Spooling Communications Subsystem (RSCS) Networking for z/VM
RSCS enables users to send messages, commands, files, and jobs to other users in a network, to send print jobs to local or remotely attached printers, and to receive remote print jobs.

Resource Access Control Facility (RACF®) Security Server for z/VM
RACF provides data security for an installation by controlling access to it.

For more information about these optional features, see Chapter 5, “z/VM optional features,” on page 63.

z/VM provides proven system integrity, security, availability, and reliability

z/VM is built on a foundation of system integrity and security, and incorporates many design features for availability and reliability:

- Integrity and security:
  - z/VM supports guest use of the cryptographic facilities provided by supported IBM servers.
  - z/VM supports drive-based data encryption with IBM System Storage tape drives. z/VM supports native and guest use of the IBM Encryption Key Manager for encryption of tapes.
  - z/VM supports IBM Fibre Channel Endpoint Security between an IBM z15® T01, IBM LinuxONE III LT1, IBM z16 family server and later, and the DS8900F; this includes the ability to query the encryption and authentication states of FCP devices and channel paths.
  - z/VM supports the use of DASD volumes that reside on data encryption drives (DEDs).
  - Support for Transport Layer Security (TLS) and Secure Sockets Layer (SSL) is provided through TCP/IP for z/VM. The z/VM 7.3 System SSL module has been designed to conform to the Federal Information Processing Standard (FIPS) 140-2. This industry-recognized cryptographic standard mandates modern digital key sizes and integrity checking for TLS operations. z/VM 7.3 System SSL is used by the z/VM LDAP server and the z/VM TLS/SSL server.

    IBM intends to pursue an evaluation of the FIPS 140-3 using NIST Cryptographic Module Validation Program (CMVP) for the System SSL implementation delivered with z/VM 7.4.
  - Integrated access control and authentication services can be augmented with the addition of an external security manager (ESM), such as the RACF Security Server for z/VM. RACF can also be used to audit connections to z/VM real devices.
  - RACF Security Server for z/VM supports Multi-Factor Authentication (MFA), which provides for the establishment of a user's identity by utilizing more than one type of authentication.
  - z/VM 7.3 has been designed to conform to the BSI Operating System Protection Profile (OSPP) with Virtualization (-VIRT) and Labeled Security (-LS) extensions of the Common Criteria standard for IT security at an Evaluation Assurance Level (EAL) of 4+ and the NIAP Virtual Protection Profile (VPP).

IBM z/VM 7.4 has successfully been evaluated to the Common Criteria (ISO/IEC 15408), in accordance with the BSI Operating System Protection Profile (OSPP), with virtualization and labeled security extensions, at an Evaluation Assurance Level of EAL 4+. This evaluated configuration includes the Single System Image function and RACF Security Server feature, as well as support for the IBM Z Multi-factor Authentication product. More information about the certificate can be found at z/VM Security and Integrity Resources (https://www.vm.ibm.com/security/).

IBM also intends to pursue an evaluation of z/VM 7.4 with the Single System Image function and RACF Security Server feature for conformance to the NIAP Virtualization Protection Profile (VPP) 1.1 and the Server Virtualization Extended Package of the Common Criteria standard for IT security (ISO/IEC 15408).

  - RSCS TCPNJE traffic can be encrypted by directing the flow through a TLS/SSL server.
  - VM/Pass-Through Facility (PVM) connectivity across TCP/IP can be encrypted by directing the flow through a TLS/SSL server.

  IBM develops and maintains z/VM in accordance with its Secure Engineering best practices and principles. These processes include, but are not limited to: risk assessment, threat modeling and vulnerability analysis, code scanning, security scanning, and penetration-testing. IBM will correct any security or integrity exposures introduced by unauthorized programs into the hypervisor layer.
- Availability and reliability:
  - Application recovery: z/VM provides services which permit recovery of incomplete interactions with resource managers.
  - Automated operations: z/VM offers several levels of automated system management support. One example is the Programmable Operator. For a higher degree of automation, IBM Operations Manager for z/VM can be added.
  - z/VM provides duplexed data with transparent ongoing synchronization between the primary and backup copy, and automatic transparent switching to the backup copy in case of an error in the primary copy.
  - Online configuration changes eliminate many previously required outages.
  - z/VM systems can be connected for improved server and user availability.
  - Fast restart reduces the end user impact of any outage.
  - Setting up an SSI cluster and using live guest relocation allows z/VM and hardware maintenance to be less disruptive to workloads and allows less disruptive workload balancing.

z/VM supports application development and deployment

Applications for the CMS environment can be written in a variety of languages, including:

- APL2®
- Assembler
- C and C++
- COBOL
- FORTRAN
- Pascal
- PL/I
- REXX

z/VM also provides a rich set of application development services, including:

- Integrated editors and support for code version management
- Trace and debug facilities

z/VM supports program development not only for z/VM applications, but also for operating systems supported as guests of z/VM.

z/VM application programming interfaces (APIs) include:

- Certain CP and CMS control blocks
- CP and CMS monitor records
- CP assembler macros (such as IUCV and APPCVM)
- CP DIAGNOSE instructions
- CP system services (such as *MSG)
- Data record formats, such as accounting records, intended to be processed by application programs
- GCS assembler macros
- System and user exits
- TCP/IP APIs (such as C sockets, IUCV sockets, Remote Procedure Calls (RPCs), and monitor records)

Special facilities are available to CMS applications, such as:

- Architectures supported:
  - Enterprise Systems Architecture/Extended Configuration (ESA/XC) support
  - z/Architecture® Extended Configuration (z/XC) support
- Assembler macros and functions
- Callable services library (CSL)
- CMS multitasking services
- CMS Pipelines
- DOS/VSE support
- Language Environment
- MQSeries® Client library
- OpenExtensions (POSIX interfaces and shell)
- OS/MVS simulation
- Program Management Binder
- Reusable Server Kernel
- REXX sockets API
- SAA Common Programming Interface - Communications (CPI-C) library
- Systems management API

Note: Although IBM VSE/VSAM, 6.1 (5686-081), was withdrawn from marketing on September 30, 2005, CMS DOS/BAM will continue to provide its current level of function in support of DOS simulation and VSE/VSAM.

In general, z/VM programming interfaces are designed to be used exclusively from programs (often using binary or other machine-level formats as parameter values) and are usually supported in a compatible manner from release to release.

z/VM might also ship other program materials (primarily macros), but these are internal facilities designed only for use between z/VM components and modules and are not intended to be used as programming interfaces.

z/VM is accessible by people with disabilities

The following features support use by people with disabilities:

- Operation by keyboard alone
- Optional font enlargement and high-contrast display settings
- Screen readers and screen magnifiers tested for use by people with visual impairment

Subcapacity pricing terms for z/VM and select z/VM-based programs

Subcapacity pricing is available to clients running on the z/VM Version 7 platform. Software pricing at less than full machine capacity can provide more flexibility and improved cost of computing as a client manages the volatility and growth of new workloads. For more information about subcapacity pricing terms for z/VM and z/VM-based programs, see IBM United States Software Announcement 217-267, dated July 17, 2017 (https://www.ibm.com/common/ssi/rep_ca/7/897/ENUS217-267/ENUS217-267.PDF).

z/VM Continuous Delivery model

By adopting this model, IBM helps clients to benefit faster from new functions and capabilities with the z/VM product. With this model, IBM changes the way z/VM function and service are delivered:

- New z/VM function, as New Function APARs, is delivered in the service stream of the current Version 7 release. When a new release is introduced, New Function APARs are delivered on that release and, with a few exceptions, the earlier release delivers corrective service only and no new function. The most notable exceptions from the corrective-service-only policy for z/VM 7.3 will be features required for hardware toleration and security compliance. Aside from these exceptions, with the availability of z/VM 7.4, licensed users of z/VM 7.3 will receive only corrective service.
- With z/VM Version 7, IBM continues to deliver product enhancements to its z/VM advanced virtualization technology on IBM Z and LinuxONE servers using the z/VM Continuous Delivery model. This model for new functions offers clients timely support for new technology throughout the life of a z/VM release using a delivery mechanism that is familiar to clients and time tested. Because the z/VM Continuous Delivery model is not centered around a release date, it allows schedule flexibility as IBM partners with the z/VM community in the design, development, and delivery of new functions. z/VM Version 7 releases will include:
  - Previously-released PTFs for New Function APARs
  - New function that is too disruptive or pervasive to ship in the z/VM service stream
  - Fixes that were shipped in the service stream of the earlier release

z/VM clients will continue to receive the same world-class support and assistance from IBM to which they are accustomed as part of the Software Subscription and Support (S&S) offering.

For detailed information about the z/VM Continuous Delivery model, see *z/VM: Migration Guide*.

z/VM documentation enabled for Continuous Delivery capability

Starting with z/VM Version 7, IBM has enabled the z/VM documentation for Continuous Delivery capability, to update z/VM topics in IBM Documentation - z/VM (https://www.ibm.com/docs/en/zvm), publications in PDF format, and help files to support New Function APARs. For details on the implementation of Continuous Delivery capability, see *z/VM: Migration Guide*.

For more details, see “Where to get information about z/VM” on page 69.

Interaction with the z/VM community

IBM has a long history of working with clients to deliver capabilities to improve z/VM. IBM continues this interaction:

- IBM enlists z/VM clients as "Sponsor Users" to advise IBM throughout the design process for many z/VM development projects. These clients may also test early versions of the new support prior to its delivery to the marketplace to ensure their expectations are met or exceeded. IBM finds the Sponsor User relationship to be beneficial and encourages more z/VM clients to become involved in this process. To learn more about the z/VM Sponsor User program, see IBM z/VM Sponsor User information (https://www.vm.ibm.com/sponsor_user/).

- For selected z/VM development projects, IBM publishes information throughout the development cycle to help users decide whether they want to volunteer as Sponsor Users and also to help the community at large plan for the introduction of new z/VM function. This level of communication between IBM and the z/VM user community facilitates discussion regarding customer needs as well as implications of the planned support (such as changes to system behavior, software vendor impacts, and operational incompatibilities).

  These plans are posted and updated on IBM: z/VM Continuous Delivery News (https://www.vm.ibm.com/newfunction/).

Chapter 2. What is new or changed in z/VM 7.4

When considering new enhancements to z/VM, the information in the following notes may be helpful.

Introductory notes:

1. **Several z/VM 7.4 enhancements were also added to z/VM 7.3, as indicated in Table 1 on page 9. For information about those and other updates to z/VM 7.3, see the What is new or changed in z/VM 7.3 topic in the 7.3 edition of *z/VM: General Information*.**
2. Some z/VM facilities and functions might require additional hardware or software support. See Chapter 3, “Technical information,” on page 23.
3. For information about PTF availability for APARs, see the following web pages:
   - IBM: z/VM Continuous Delivery News (https://www.vm.ibm.com/newfunction/)
   - z/VM service required for the IBM z17 family servers (https://www.vm.ibm.com/service/vmreqz17.html)
   - z/VM service required for the IBM z16 family servers (https://www.vm.ibm.com/service/vmreqz16.html)
   - z/VM service required for the IBM z15 family servers (https://www.vm.ibm.com/service/vmreqz15.html)
4. To get the most up-to-date list of (and more information about) CP environment variables that define new z/VM functions, go to:
   - IBM: z/VM New Function Variable List (https://www.vm.ibm.com/newfunction/varlist.html)
5. To get the most up-to-date list of (and more information about) z/VM service environment variables, go to:
   - z/VM Service Environment Variable List (https://www.ibm.com/vm/service/zvmsrvev.html)
6. For additional information about changes to external interfaces in z/VM, see *z/VM: Migration Guide*.

The links in the following table take you to descriptions of the product enhancements and other changes that are available in z/VM 7.4.

Table 1. Links to z/VM 7.4 enhancement categories, availability, and descriptions

Category	Availability (in z/VM 7.4 base or post-GA APAR)	Description of enhancement
Product packaging	7.4 base	“[7.4] Integration of HCD and HCM for z/VM into the CP component base” on page 11
	7.4 base	“[7.4] Removal of physical DVDs as a product distribution medium” on page 11
	7.4 base	“[7.4] Discontinuance of support for EREP VM 3” on page 12
Installation, migration, and service	7.4 base	“[7.4] Installation changes” on page 12
	7.4 base	“[7.4] Linear service” on page 12
	7.4 base	“[7.4] New format for service level” on page 13
	Post-GA APAR VM66834	“[7.4 APAR] GETSHOPZ ServiceLink support” on page 13
	Post-GA APAR VM66840	“[7.4 APAR] z/VM linear service environment variables” on page 13

Table 1. Links to z/VM 7.4 enhancement categories, availability, and descriptions (continued)

Category	Availability (in z/VM 7.4 base or post-GA APAR)	Description of enhancement
Support and exploitation of hardware and architectures, and hypervisor efficiency and scalability	7.4 base	"[7.4] Architecture level set (ALS)" on page 13
	Post-GA APARs: VM66829 (CP) VM66830 (DVF)	"[7.4 APAR] TRSOURCE support for five-digit real device addresses" on page 13
	Post-GA APARs: VM66839 (7.4) VM66832 (7.3)	"[7.4, 7.3 APARs] Single system image (SSI) prerequisite support for future-server compatibility" on page 14
	Post-GA APARs: VM66824,VM66854, and VM66877 (7.4 CP) VM66858 (7.4 RACF) VM66823, VM66853, and VM66878 (7.3 CP) VM66857 (7.3 RACF)	"[7.4, 7.3 APARs] z/VM support for the IBM z17 family" on page 14
	Post-GA APARs: VM66877 (7.4) VM66878 (7.3)	"[7.4, 7.3 APARs] Enhanced QDIO virtual switch vNIC simulation" on page 16
	Post-GA APARs: VM66844 (7.4) VM66850 (7.3)	"[7.4, 7.3 APARs] Transactional execution disablement" on page 16
Connectivity and networking	7.4 base	"[7.4] Removal of support for LAN Channel Station (LCS) emulation" on page 17
	Post-GA APARs: PH65378 and PH67661 (7.4) PH65377 and PH67660 (7.3)	"[7.4, 7.3 APARs] z/VM TCP/IP support for enhanced QDIO" on page 17

Table 1. Links to z/VM 7.4 enhancement categories, availability, and descriptions (continued)

Category	Availability (in z/VM 7.4 base or post-GA APAR)	Description of enhancement
System administration, operation, and ease of use	7.4 base	"[7.4] Removal of obsolete crypto support" on page 17
	7.4 base	"[7.4] Removal of use of DVHWAKE module" on page 18
	Post-GA APAR VM66829	"[7.4 APAR] Two-speed Monitor sampling" on page 18
	Post-GA APARs: VM66828 (7.4) VM66822 (7.3)	"[7.4, 7.3 APARs] SMAPI support for enhanced QDIO" on page 18
	Post-GA APARs: VM66826 (7.4) VM66825 (7.3)	"[7.4, 7.3 APARs] z/VM Performance Data Pump enhancements" on page 18
	Post-GA APAR VM66872	"[7.4 APAR] Unified DIFF and PATCH support for CMS" on page 19
	Post-GA APAR VM66877	"[7.4 APAR] Fast LOGOFF control" on page 19
Security	VM66873	"RACF utility enhancements" on page 19
Application development and deployment	Post-GA APARs: VM66874 (DirMaint) VM66872 (SMAPI)	"[7.4 APAR] DirMaint and SMAPI LOADDEV ALTERNATE directory support" on page 19
	Post-GA APAR VM66872	"[7.4 APAR] SMAPI support for querying linear service" on page 20
System diagnosis	Post-GA APAR VM66877	"[7.4 APAR] Soft abend improvements" on page 20

Product packaging: z/VM 7.4 General Availability (GA) enhancements

The following topic or topics describe the product packaging enhancements introduced at the General Availability (GA) of the current release of z/VM.

[7.4] Integration of HCD and HCM for z/VM into the CP component base

The functional executables of the Hardware Configuration Definition and Hardware Configuration Manager for z/VM (HCD and HCM for z/VM) are now shipped as part of the CP component of z/VM 7.4. Service support is provided with the CP component of z/VM.

[7.4] Removal of physical DVDs as a product distribution medium

DVD-R is no longer a supported system image distribution medium. The replacement for installing from a physical DVD on an HMC is to use a USB flash drive. An electronic image in ISO format will be provided. Customers can copy the contents of the electronic image to a USB flash drive by following instructions provided with their order. Only USB flash drives supported by the HMC can be used.

This satisfies the Statement of Direction from the z/VM 7.3 product announcement.

For complete installation instructions, see the *z/VM: Installation Guide*.

[7.4] Discontinuance of support for EREP VM 3

In response to Withdrawal Announcement AD24-0128 indicating that EREP VM 3 will be withdrawn from service effective 28 February 2025, EREP product support for record retrieval and reporting has been removed from z/VM 7.4. In addition, EREP packaging infrastructure has been removed from z/VM 7.4.

This satisfies the z/VM statement of direction announced March 26, 2024.

Installation, migration, and service: z/VM 7.4 General Availability (GA) enhancements

The following topic or topics describe the installation, migration, and service enhancements introduced at the General Availability (GA) of the current release of z/VM.

[7.4] Installation changes

Installation changes for z/VM 7.4 include the following:

- The upgrade installation process allows you to upgrade from z/VM 7.2 or 7.3 to z/VM 7.4.
- z/VM 7.4 includes a sample EXEC — IMAGHASH — on the installation media. You can use this EXEC to generate SHA256 hash values for a set of image files and compare those hash values with reference values that are now included in supplied installation DVDHASH files.
- z/VM 7.4 requires that customers supply a default user directory password when a z/VM system is installed or upgraded. Reliance on or use of an IBM-supplied default user ID password is no longer possible.
- The option to install z/VM 7.4 from a Hardware Management Console CD / DVD-ROM (HMC DVD) drive has been removed.
- Starting with z/VM 7.4, Preventive Service Planning (PSP) buckets will no longer be created for product releases.
- The TCPIP user directory entry has been updated to IPL 990 (ZCMS).
- Installation support is added for the performance DATAPUMP user ID.
- A hash value has been added to the DVDIMAGE file for each file on each DVD/ZIP.
- The installation password for DIRMAINT has been updated from AUTOONLY to LOGONBY.
- The RLDSAVE option is no longer specified in the 7VMCPR40 PPF file for the build of the CPLOAD module.

For more information, see the *z/VM: Installation Guide*.

[7.4] Linear service

z/VM 7.4 introduces linear service to the product for components at the 740 function level. Corrective service updates — in the form of fix packs, hot fixes, and hardware support — and new functions in feature packs are released in service stream PTFs. The latest PTF identifies the requisites of all fixes and features for a component up to that point. For more information about linear service, including schedules and the types of APARs, see:

Introducing z/VM Linear Service (https://www.vm.ibm.com/service/linear.html)

This satisfies the z/VM Statements of Direction included in the IBM z16® A02 and AGZ announcement and the IBM LinuxONE LA2 and AGL announcement dated April 4, 2023.

[7.4] New format for service level

The product service level, as reported by z/VM components with a query service command, uses new format *ffxx*:

- *ff* indicates the latest feature pack number.
- *xx* indicates the fix pack number for the latest feature pack.

Installation, migration, and service: z/VM 7.4 post-GA APARs

The following topic or topics describe the installation, migration, and service enhancements introduced in post-GA APARs of the current release of z/VM.

[7.4 APAR] GETSHOPZ ServiceLink support

With the PTF for APAR VM66834, z/VM 7.4 provides GETSHOPZ support for direct-to-host transfer of service packages from IBM ServiceLink. Clients currently use the GETSHOPZ utility to securely transfer z/VM service packages directly from Shopz. This support provides the same ability for ServiceLink orders.

[7.4 APAR] z/VM linear service environment variables

With the PTF for APAR VM66840, environment variables are established to provide the ability to easily determine the latest service that is installed on a z/VM 7.4 system. z/VM linear service environment variables allow administrators or automation to view the linear service level from CP, CMS, or a Linux guest.

Support and exploitation of hardware and architectures, and hypervisor efficiency and scalability: z/VM 7.4 General Availability (GA) enhancements

The following topic or topics describe hardware currency and exploitation enhancements introduced at the General Availability (GA) of the current release of z/VM.

[7.4] Architecture level set (ALS)

z/VM 7.4 requires a new architecture level set (ALS) and supports only IBM z15 family or later servers.

- Appendix A, “IBM servers supported by z/VM,” on page 85
- Introducing z/VM Linear Service (https://www.vm.ibm.com/service/linear.html) for an explanation of linear service and to access z/VM change logs.
- IBM: z/VM 7.4 Architecture Level Set (https://www.ibm.com/vm/zvm740/architecture).

This satisfies the Statement of Direction from the z/VM 7.3 product announcement.

Support and exploitation of hardware and architectures, and hypervisor efficiency and scalability: z/VM 7.4 post-GA APARs

The following topic or topics describe the hardware currency and exploitation enhancements introduced in post-GA APARs of the current release of z/VM.

[7.4 APAR] TRSOURCE support for five-digit real device addresses

With the PTFs for APARs VM66829 (CP) and VM66830 (DVF), support is added to z/VM 7.4 to specify and display subchannel sets on trace definitions. The TRSOURCE ID command accepts and the QUERY

TRSOURCE command displays five-digit real device addresses where the high-order digit indicates the subchannel set. If a four-digit address is specified, the subchannel set is assumed to be 0.

[7.4, 7.3 APARs] Single system image (SSI) prerequisite support for future-server compatibility

The PTFs for APARs VM66839 (7.4) and VM66832 (7.3) provide infrastructure support in z/VM for inclusion of an IBM z17® family server in a single system image (SSI) cluster. Proper guest relocation support requires that the PTF is installed on all the members of an SSI cluster before any member runs on an IBM z17 family server.

Users of z/VM single system image (SSI) with live guest relocation (LGR) may encounter either of the following during LGR:

- This message:

```
Message HCP1940E userid is not relocatable for the following reason(s):
HCP1944I userid: Architecture incompatibility
```

Or:

- Output from the QUERY VMRELOCATE *userid* command that includes:

```
HCP1818I Excluded members: system_names when a z17 member is
dynamically added to a relocation domain with mixed levels of z17 and non-z17 support.
```

In this case:

z17 support
refers to APAR VM66823 for z/VM 7.3 and VM66824 for z/VM 7.4.

non-z17 support
refers to any version of z/VM without either VM66823 or VM66824 applied.

dynamically added
refers to either addition to a relocation domain via CEC-swap or redefinition of an existing relocation domain to include the new member.

To avoid this issue:

For z/VM 7.3
Apply VM66823 to all members of the relocation domain to which you wish to add an IBM z17.

For z/VM 7.4
Apply VM66824 to all members of the relocation domain to which you wish to add an IBM z17.

Should you not be able to apply the corrective service, these workarounds are available:

1. Once a member is excluded, you can shutdown/re-ipl one of the members in the existing relocation domain that does not have the IBM z17 support applied.
2. You can define a new relocation domain including the IBM z17 and use SET VMRELOCATE to change the relocation domain of the virtual machine (vm) to the new domain.
3. You can use the FORCE ARCHITECTURE operand on the VMRELOCATE command. Typically, this would not clear the excluded member, but in this case, that member will be cleared from the list and the virtual machine is able to relocate freely around the domain.

[7.4, 7.3 APARs] z/VM support for the IBM z17 family

Important: Installations that include usage of z/VM vendor products should check with the vendor whether additional service is required before IPLing z/VM on the IBM z17.

Any users of HCPVINOP MACRO are required to recompile their local updates before applying the PTF for APAR VM66824 (7.4 CP) or VM66823 (7.3 CP). Users of vendor products should contact the vendor to inquire whether the vendor uses the HCPVINOP macro. If so, users should obtain recompiled source from the vendor.

A SIT002 ABEND is a strong indicator for an included part that has not been recompiled with the IBM z17 CP APAR. The part could have been included either during the build of the CPLOAD MODULE or with a CPXLOAD during operation.

This is an incompatible change.

With the PTFs for these APARs, z/VM 7.4 and 7.3 provide the features in the list that follows:

- VM66824, VM66854, and VM66877 (7.4 CP)
- VM66858 (7.4 RACF)
- VM66823, VM66853, and VM66878 (7.3 CP)
- VM66857 (7.3 RACF)

Features provided:

- Guest exploitation enablement for the following new facilities:
  - Vector-Enhancements Facility 3 — New instructions intended to provide performance improvements.
  - Vector-Packed-Decimal-Enhancement 3 — Intended to provide performance improvements of COBOL programs when compiled using the NUMCHECK option to detect and convert data.
  - Workload-Instrumentation — Provides a means of classifying and sampling workloads to enhance the z/OS® pricing model.
  - Message-Security-Assist Extensions — Enhancements that allow the use of XTS and HMAC algorithms and allow for generation of XTS and HMAC encryption keys while using AES algorithms.
  - Perform Lock Operation (PLO) — Provides operations for managing locks in storage to replace capabilities provided previously by the constrained transactional execution (CTX) facility.
  - Concurrent-Functions — Provides new instructions intended to replace the use of TX for software serialization.
  - Spyre Accelerator Adapter — Offers scalable capabilities for complex AI models and generative AI use cases.
- Host support for the following new facilities:
  - Power® Consumption metrics provided within the z/VM monitor — Enhancements to the z/VM monitor to include power consumption information for an entire CPC or LPAR. This information includes power metrics for CPU, I/O, and memory usage. Consumers of the z/VM monitor, such as the z/VM Performance Data Pump, can be enhanced to calculate and approximate guest-level apportionment. Support for the z/VM Performance Data Pump power metric dashboard requires Performance Toolkit PTFs for APARs VM66826 (7.4) and VM66825 (7.3).
  - CPU Measurement Facility (CPU-MF) enhancements — Provide CPU-MF-specific support for the IBM z17 family.
  - Data Processing Unit (DPU) Next Generation I/O accelerator instrumentation provided within the z/VM monitor — Collects FCP, FICON®, and OSA instrumentation data within the z/VM monitor for the IBM z17 family DPUs.
- Real device support — Allows the following devices to be attached for guest exploitation:
  - EQDIO (OSH) devices.
  - Network Express Hybrid (NETH) devices.

- Dynamic I/O and HCD support is added for the following components:
  - EQDIO (OSH) CHPIDs and subchannels.
  - CL6 coupling adapter CHPIDs.
  - Network Express Hybrid (NETH) PCIe functions.
- Guest exploitation support for EQDIO devices — Allows guests to directly exploit the OSH functionality of the Network Express Adapter.
- Extension of CP virtual switch logic for Network Express Adapter EQDIO support within the z/VM virtual switch — Allows customers to configure the virtual switch to take advantage of lower latency and higher bandwidths that are provided by networking EQDIO devices within their data center. The virtual switch EQDIO exploitation includes QDIO-to-EQDIO translation, which allows guests that do not support EQDIO to directly take advantage of this networking support.

  "Multi-VSwitch Link Aggregation" requires the PTFs for APARs VM66877 (7.4) and VM66878 (7.3), and driver D61C Bundle #15.

  Restriction: The restriction described here has been lifted with the PTFs for APARs VM66877 (7.4) and VM66878 (7.3), and driver D61C Bundle #15:

  - A z/VM virtual switch that supports Network Express OSH does not currently support guests that exploit an EQDIO uplink port. In the interim, clients are required to use either a guest-attached OSH device or existing functionality that is available with OSA-Express7S adapters.

  Note: The following special considerations apply to a CHPID that is defined with the LINK_AGGREGATION parameter for Network Express (OSH) devices.

  The LINK_AGGREGATION parameter on the DEFINE CHPID command, or the corresponding CHPARM in the IOCP (x02), indicates that the specified CHPID is to be used only for link aggregation. When the CHPID is defined in link aggregation mode, the device can be used only as part of a port group for z/VM virtual switch link aggregation. When the CHPID is not defined in link aggregation mode, attempts to bring up a z/VM virtual switch that is configured to use the device as part of a link aggregation port group will fail if either of the following conditions are true:

  - A NETH device is also configured on the port.
  - The system is managed by IBM Dynamic Partition Manager.
- Reduced support for transactional execution (TX) — Non-constrained transactions will result in unconditional termination with condition code 1 (CC1) set and no transaction diagnostic block (TDBK) stored.

[7.4, 7.3 APARs] Enhanced QDIO virtual switch vNIC simulation

With the PTFs for APARs VM66877 (7.4 CP) and VM66878 (7.3 CP), and driver D61C Bundle #15, z/VM 7.4 and 7.3 provide guests with the ability to define simulated enhanced QDIO (EQDIO) network interface cards (vNICs) on the virtual switch. With this support, a guest has the option to establish and activate a network connection in either traditional QDIO or EQDIO mode. QDIO mode requires three devices to activate a network connection but EQDIO mode requires only a single device.

[7.4, 7.3 APARs] Transactional execution disablement

With the PTFs for APARs VM66844 (7.4 CP) and VM66850 (7.3 CP), z/VM 7.4 and 7.3 provide support for transactional execution disablement. This support introduces a way to test application migration and detect usage of the transactional-execution facilities with z/VM 7.4 and 7.3, thus preparing z/VM 7.4 and 7.3 users for the eventual reduction and removal of support for these facilities.

Connectivity and networking: z/VM 7.4 General Availability (GA) enhancements

z/VM 7.4 includes changes to the connectivity and networking features of z/VM.

[7.4] Removal of support for LAN Channel Station (LCS) emulation

Support for the OSE CHPID type, which is used to provide LAN Channel Station (LCS) emulation, is discontinued. TCP/IP no longer supports the LCS device driver. LCS documentation is removed from z/VM publications.

This satisfies the Statement of Direction from the z/VM 7.3 product announcement.

Connectivity and networking: z/VM 7.4 post-GA APARs

The following topic or topics describe the connectivity and networking improvements introduced in post-GA APARs of the current release of z/VM.

[7.4, 7.3 APARs] z/VM TCP/IP support for enhanced QDIO

With the PTFs for APARs PH65378 and PH67661 (7.4) and PH65377 and PH67660 (7.3), z/VM 7.4 and 7.3 provide a native network device driver for the z/VM TCP/IP stack that uses enhanced QDIO (EQDIO) adapters for network transport.

Note: The EQDIO device driver requires the TCPIP user ID to be configured to IPL ZCMS by default after the IBM z17 support has been applied.

System administration, operation, and ease of use: z/VM 7.4 General Availability (GA) enhancements

The following topic or topics describe system administration, operation, and ease-of-use enhancements introduced at the General Availability (GA) of the current release of z/VM.

[7.4] Removal of obsolete crypto support

Support for the following obsolete user directory operands related to crypto has been removed:

- The CRYPTO operand on the CPU directory statement
- The CSU, KEYENTRY, MODIFY, and SPECIAL operands on the CRYPTO directory statement

These operands should be removed from the USER DIRECT file prior to running the DIRECTXA MODULE that is supplied with z/VM 7.4 and prior to IPLing a z/VM 7.4 CPLOAD MODULE. Directory manager (such as DirMaint) directory updates will fail if the obsolete directory statements are not removed from existing entries in the user directory.

The following keyword combinations are no longer allowed in the same CRYPTO user directory entry:

- APVIRTUAL and DOMAIN
- APVIRTUAL and APDEDICATED

The CRYPTO and NOCRYPTO options are not allowed with the CPU operation of the DIAGNOSE code X'84' (Directory Update-In-Place) instruction. The DIAGNOSE code X'84' instruction no longer issues return code 246.

[7.4] Removal of use of DVHWAKE module

DirMaint has been updated in z/VM 7.4 to remove the use of the DVHWAKE MODULE. While the DVHWAKE MODULE is still shipped with DirMaint, any customized user exits should be updated to use the CMS WAKEUP command.

System administration, operation, and ease of use: z/VM 7.4 post-GA APARs

The following topic or topics describe the system administration, operation, and ease of use improvements introduced in post-GA APARs of the current release of z/VM.

[7.4 APAR] Two-speed Monitor sampling

With the PTF for APAR VM66829, support is added to z/VM 7.4 to collect z/VM Monitor data at two different sampling rates. Particular guests can collect detailed data for a relatively brief period and preserve the data in case a situation arises that requires the data for analysis. Other guests can collect data less frequently and over longer time periods for customary purposes such as real-time monitoring or feeding the z/VM Performance Data Pump.

[7.4, 7.3 APARs] SMAPI support for enhanced QDIO

With the PTFs for APARs VM66828 (7.4) and VM66822 (7.3), z/VM 7.4 and 7.3 provide support that allows users to develop or enhance system management tools that are related to enhanced QDIO (EQDIO) devices.

For more information, see:

- *z/VM: Systems Management Application Programming*

[7.4, 7.3 APARs] z/VM Performance Data Pump enhancements

Performance Toolkit statement of support: The Performance Toolkit Data Pump dashboards have been updated to provide information that is specific to the new architectures delivered with the IBM z17 family of servers. The 3270 and web interfaces of the Performance Toolkit are stabilized at the IBM z16 architecture level and will not reflect new hardware and facilities delivered with the IBM z17 or any future families of servers.

With the PTFs for APARs VM66826 (7.4) and VM66825 (7.3), z/VM 7.4 and 7.3 provide support for a new z/VM Performance Data Pump dashboard. The dashboard provides a graphical representation of IBM z17 family power consumption metrics from the z/VM monitor stream. The display includes information for the following components:

- CPC
- LPAR
- CPU
- I/O
- Memory

The information can be used to calculate or approximate guest level apportionment.

Information about setting up Data Pump is available. See z/VM Performance Data Pump in *z/VM: Performance*.

Information is available about other services that process the Data Pump output stream, including links to Grafana sample dashboards. See z/VM Performance Data Pump (https://www.vm.ibm.com/related/perfkit/datapump/).

[7.4 APAR] Unified DIFF and PATCH support for CMS

With the PTF for APAR VM66872, z/VM 7.4 provides the new utilities UDIFF and UPATCH, which are an implementation within z/VM of Linux DIFF/PATCH functionality.

UDIFF compares two files and generates an output file with detected differences (such as modified records, added records, and removed records) as well as a "context" consisting of surrounding records, so that the unique position of the changes is explicit.

UPATCH is the companion application, which takes the patch and source files as input and generates an output file. The output of UPATCH matches the contents of the file used as input to UDIFF.

The UDIFF and UPATCH implementation uses the unified diff file format, which is the most widespread format currently in use within the technology industry. The unified diff format is utilized by text editors, source code management software, operating systems, and other critical software.

[7.4 APAR] Fast LOGOFF control

With the PTF for APAR VM66877, z/VM 7.4 provides control of the behavior of a virtual machine's memory reset during LOGOFF. With fast logoff control, clients can avoid inadvertent memory over-commitment by preventing a logged off virtual machine from being logged back on until the virtual machine's memory reset is complete.

Security: z/VM 7.4 post-GA APARs

The following topic or topics describe the security enhancements introduced in post-GA APARs of the current release of z/VM.

RACF utility enhancements

With the PTF for APAR VM66873, z/VM 7.4 provides the ability to use RACF utilities RACUT200 and RACUT400 non-interactively (by passing them input parameters from the command line) rather than interactively (by responding to system prompts, as was previously required). The amount of input that users must enter is reduced by setting default values for certain parameters and by allowing abbreviations for certain parameters.

Application development and deployment: z/VM 7.4 post-GA APARs

The following topic or topics describe the application development enhancements introduced in post-GA APARs of the current release of z/VM.

[7.4 APAR] DirMaint and SMAPI LOADDEV ALTERNATE directory support

With the PTFs for APARs VM66874 (DirMaint) and VM66872 (SMAPI), z/VM 7.4 provides the ability for DirMaint and SMAPI to support the addition, modification, and deletion of LOADDEV ALTERNATE statements in the user directory.

[7.4 APAR] SMAPI support for querying linear service

With the PTF for APAR VM66872 (CMS), z/VM 7.4 provides the ability for the user to query and access this information:

- Linear Service and RSU details for a specified component ID or all components
- Service level and production-level details for a specified component ID or all components, making it easier to identify the latest installed service on a z/VM 7.4 system for a specific component or all components
- A list of all APARs and PTFs for a specific component ID

System diagnosis: z/VM 7.4 post-GA APARs

The following topic or topics describe the system diagnosis enhancements introduced in post-GA APARs of the current release of z/VM.

[7.4 APAR] Soft abend improvements

With the PTF for APAR VM66877, z/VM 7.4 provides support that allows the number of soft abend dumps to be limited and enables a soft abend dump to be skipped if it would result in a hard abend. With this support, clients can keep their systems up when soft abends occur. Non-fatal problems can be prevented from causing system outages and dump space can be preserved for SNAPDUMP or hard abend dumps by limiting the number of soft abend dumps. A soft abend history table can be reviewed to assess whether there might be any problems with the system.

Statements of direction

The following z/VM Statement of Direction was included in the IBM z16 A02 and AGZ announcement and the IBM LinuxONE LA2 and AGL announcement dated April 4, 2023:

Full-part-replacement
IBM intends to change how z/VM service is delivered in a future z/VM release. Instead of CMS update files, full-part-replacement files will be provided. In addition, full-part-replacement files will no longer contain sequence numbers, which are character line identifiers in the last eight characters of every line in a fixed record file. z/VM source files will be encoded using the CP1047 code page, unless stated otherwise. Tooling will be provided to assist customers or vendors who still have a need to update z/VM source files.

The following z/VM Statements of Direction were included with the z/VM 7.4 announcement dated August 6, 2024:

Removal of support for the LDAP Server
z/VM 7.4 is planned to be the last z/VM release to support the z/VM LDAP server. This server, a re-host of the z/OS Directory Server, will be removed from z/VM TCP/IP in a future release. This includes the LDAPSRV virtual machine and associated components. All future releases will continue to support ldap-bind as an authentication factor through the IBM Z Multi-Factor Authentication program (5655-MA1). CMS-based LDAP client utilities and the RACF r_admin interface, are not affected by this statement.

Removal of z/VM NFS support
z/VM 7.4 is planned to be the last z/VM release to provide NFS client and server support. NFS client and server support will be removed from z/VM TCP/IP in a future release.

z/CMS as the default CMS
z/VM 7.4 is planned to be the last z/VM release to have ESA/390 CMS as the default. A future z/VM release will use z/CMS, renamed "CMS," as the default. ESA/390 CMS, renamed "CMS390," is planned to remain available for guests that are dependent on ESA/390 or 370 accommodation.

Security evaluation of z/VM 7.4
IBM intends to pursue evaluations in anticipation of certification of z/VM 7.4 to the Common Criteria standard for IT security (ISO/IEC 15408) as described in this Statement of Direction. The Target

of Evaluation (z/VM 7.4), including the Single System image function and the RACF Security Server feature, will focus on conformance both to the National Information Assurance Partnership (NIAP) Virtualization Protection Profile (VPP) with Server Virtualization Extended Package, including labeled security; and to the Operating System Protection Profile (OSPP) at Evaluation Assurance Level (EAL) 4+.

FIPS certification of z/VM 7.4
IBM intends to pursue an evaluation of the Federal Information Processing Standard (FIPS) 140-3 using National Institute of Standards and Technology's (NIST) Cryptographic Module Validation Program (CMVP) for the System SSL implementation delivered with z/VM 7.4.

Stabilization of z/VM support for the IBM z15 family
z/VM 7.4 is planned to be the last z/VM release to support the z15 family, which includes IBM LinuxONE III. An IBM z16 family server, which includes IBM LinuxONE 4, will be the required minimum level for future z/VM releases.

The following were included with the z/VM statement of directions announcement dated May 13, 2025:

FTP installation for second level or upgrade-in-place removal
With the next release of z/VM, IBM intends to remove the ability to perform second-level installations or upgrades directly from a File Transfer Protocol (FTP) server. At that time, the z/VM installation media will need to be on a CMS minidisk in order to perform a second-level install or upgrade. First-level installations of z/VM from an IBM Z Hardware Management Console (HMC) are expected to continue to support FTP, File Transfer Protocol Secure (FTPS), or Secure File Transfer Protocol (SFTP) from an FTP server.

Integration of Removable Media Services into the base of z/VM
IBM intends to include the DFSMS/VM Removable Media Services (RMS) and Fast Copy functions with the next release of z/VM. The remaining DFSMS/VM minidisk and Shared File System (SFS) space management functions, and RMS tape mount services for remote hosts, will not be included.

Disablement of z/VM minidisk cache support
z/VM 7.4 is planned to be the last z/VM release to have minidisk cache (MDCACHE) enabled as the default. The next z/VM release will disable MDCACHE at the system level. Support for minidisk cache will be removed in a future z/VM release.

Statements regarding IBM 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 our general product direction, and it should not be relied on in making a purchasing decision. The information mentioned regarding potential future products is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. Information about potential future products may not be incorporated into any contract. The development, release, and timing of any future features or functionality described for our products remains at our sole discretion.

Chapter 3. Technical information

The following topics provide information about z/VM 7.4 requirements and capabilities:

Note: For the latest product updates, contact your IBM Support Center or see IBM: z/VM (https://www.ibm.com/vm/).

Hardware and storage requirements

There are general hardware and storage requirements for installing and operating z/VM 7.4, and some z/VM facilities have additional hardware requirements. These are described in the following topics:

Some hardware might be supported only on certain servers.

Server requirements

z/VM 7.4 requires a new architecture level set (ALS) and supports only IBM z15 family or later servers. See Appendix A, "IBM servers supported by z/VM," on page 85.

Specific server facilities might also be required. See IBM: z/VM 7.4 Architecture Level Set (https://www.ibm.com/vm/zvm740/architecture).

Installation requirements

z/VM 7.4 is available as an electronic image in ISO format. For information about receiving the electronic deliverables, see Installation Instructions for Electronically Delivered z/VM System Deliverable and Licensed Products (https://www.ibm.com/vm/install/prodinst.html).

To install z/VM:

- For first-level installation, you need access to the integrated 3270 console for your LPAR, provided through the Hardware Management Console (HMC).
- For second-level installation, you need access to a 3270 terminal (or equivalent) configured with a minimum of 32 lines and 80 columns on a currently supported level of z/VM.
- Installation from the ISO image requires IBM z15 or later.
- Installation of an SSI cluster (1 to 4 z/VM images) requires DASD defined to emulate an IBM 3390 with a minimum size of 10016 cylinders. For more information about SSI cluster requirements, see *z/VM: CP Planning and Administration*.

  Note: Post-installation use of SCSI devices by guests is permitted.
- Installation of a non-SSI system to ECKD DASD requires DASD defined to emulate an IBM 3390 with a minimum size of 10016 cylinders.
- Installation of a non-SSI system to FCP-attached SCSI LUNs requires IBM System Storage SCSI disks or equivalent with a minimum size of 6 gigabytes.

  Note: A z/VM system installed to SCSI disks cannot be converted to an SSI cluster.

For additional installation requirements, see the *z/VM: Installation Guide*.

Storage requirements

The amount of memory (storage) required to install and operate z/VM depends on several factors, such as the settings in the system configuration file, the environment where you plan to run, and the workload you want to run. "Maximum memory limits and minimum memory requirements" on page 112 indicates real and virtual memory minimum requirements and maximum limits for z/VM first and second-level systems.

As part of z/VM workload planning, or when adding additional guest workload, the amount of real memory already in use needs to be considered. Factor into this planning how much real memory is already in use and hence how much remains available. The actual amount of usable real memory is dependent on the amount of real memory in the z/VM logical partition; the hardware server model, firmware level, and configuration; and the number of guests and their workload. The amount of usable virtual memory is primarily dependent on the amount of DASD space allocated for paging, although it is also influenced by the number of guests and their workload characteristics.

Depending on the workload you plan to run, you might need to add capacity to take full advantage of the maximum real memory that is supported by z/VM. This might mean, for example, adding memory and CPUs to your existing configuration, or adding drawers to your system, or reconfiguring DASD paging space.

- To assist with planning for z/VM, additional information can be found at IBM: z/VM Technical Resources (https://www.ibm.com/vm/techinfo).
- For DASD configuration guidelines, see IBM: VM Performance Resources (https://www.ibm.com/vm/perf/).
- For guidelines on calculating the required paging space, see *z/VM: CP Planning and Administration*.

If you use a nonshared copy of CMS (or zCMS), your virtual machine size must be at least 20 MB. If you use CMS (or zCMS) as a named saved system (NSS), your virtual machine size must be at least 2 MB, provided that the CMS (or zCMS) callable services libraries (CSLs) have also been saved as a saved segment.

Workstation requirement

Many z/VM administration tasks require access to a 3270-equivalent workstation.

DPM hardware requirements

Dynamic Partition Manager (DPM), initially provided with IBM z13® family servers, supported configuring FCP SCSI storage. DPM enhancements that are provided by IBM z14® family servers with driver D32 bundle 55a support configuring FICON ECKD storage. Additional DPM enhancements that are provided by IBM z16 family servers with driver D51C bundle 28 further enhance DPM management support. The enhanced DPM support enables configuration of FICON Channel-to-Channel within the same CPC. A DPM-managed system can configure a z/VM SSI cluster within the same IBM z16 family server.

A CPC can be configured in either DPM mode or PR/SM mode. DPM mode requires two OSA-Express5S or later 1000BASE-T Ethernet adapters for primary and backup connectivity.

See the IBM z14 family exception letter in Resource Link® and the 3906DEVICE and 3907DEVICE PSP buckets for details on the driver D32 bundle providing FICON ECKD support.

With driver D32 bundle 55a, the DPM ECKD support (also known as DPM Storage Management support) has been enabled. The migration will take place automatically when installing the enablement bundle. Depending on your current FCP configuration (that is, prior to installing bundle 55a), changes in the SAN setup regarding zoning and masking are recommended. These changes are documented in IBM Z Dynamic Partition Manager (DPM) Guide (https://www.ibm.com/support/pages/ibm-z-dynamic-partition-manager-dpm-guide).

Multi-VSwitch Link Aggregation support hardware requirements

Multi-VSwitch Link Aggregation support allows a port group of OSA-Express adapters to span multiple virtual switches within a single z/VM system or between multiple z/VM systems.

The minimum hardware requirement for Multi-VSwitch Link Aggregation support is the IBM z14 family with the OSA-Express4S or IBM z17 family with the Network Express adapter.

PCIe support hardware requirements

z/VM provides support for guests to dedicate PCIe functions to their virtual machines.

The minimum hardware requirement for the zEDC Express and 10GbE RoCE Express adapters is a zEnterprise® EC12 or BC12 at driver D15 with a minimum bundle level.

The minimum hardware requirement for the IBM Adapter for NVMe is IBM LinuxONE II with driver D36.

Performance Toolkit hardware requirements

The Performance Toolkit browser interface requires a workstation that is enabled for web browsing.

Extended color and highlighting can be used when supported by the hardware. Graphic performance data displays can be shown only on terminals with graphics capability which are also supported by the IBM Graphical Data Display Manager (GDDM)/VM.

Note: z/VM Performance Data Pump does not use the z/VM Performance Toolkit browser interface.

SSI clusters hardware requirements

The following hardware is required to support a z/VM single system image (SSI) cluster:

- The z/VM systems must be installed on ECKD DASD. Post-installation use of SCSI devices by guests is supported.
- The SSI persistent data record (PDR) must be created on a shared 3390 DASD volume. All other DASD shared by the members of the cluster can be ECKD or FBA devices.
- The z/VM systems require the following connectivity:
  - FICON channels to support 1 to 16 direct ISFC links from each member to each of the other members of the cluster
  - FICON channels to the shared DASD

  - OSA access to the same LAN segments
  - (If needed) FCP access to the same storage area networks (SANs) with the same storage access rights

TCP/IP hardware requirements

For connectivity to a local network, one of the following is required:

- IBM Open Systems Adapter (OSA)
- IBM Z HiperSockets
- IBM FICON Channel-to-Channel Adapter
- z/VM IUCV

VM Guest RSA-Assist Support for Linux hardware requirements

In order for the VM Guest RSA-Assist Support for Linux to operate, the following are required:

- Corresponding function in Linux on IBM Z
- Crypto Express5S or later

zHPF guest support hardware requirements

z/VM provides support for guest use of the High Performance FICON for IBM Z (zHPF) feature. The minimum hardware required is determined by the program running in the virtual machine. The minimum hardware requirement varies with different programs. See the publications for the program being used to determine what is required. In addition, a few zHPF features are limited to fullpack minidisks or attached DASD.

zHPF paging hardware requirements

z/VM uses High Performance FICON for IBM Z (zHPF) for paging when enabled with the FEATURES ENABLE PAGING_ALIAS system configuration statement or the SET PAGING ALIAS ON command, and the hardware supports the required features.

The minimum hardware required is:

- FICON Express8S
- One of the following or newer:
  - System Storage DS8800 Release 6.2 Bundle 86.20.98.0 (November 2011)
  - System Storage DS8870 Release 7.0 Bundle 87.0.189.0 (October 2012)
  - System Storage DS8880 Release 8.0 Bundle 88.0.153.0 (December 2015)

Additional information on hardware configurations can be found at IBM System Storage Interoperation Center (SSIC) (https://www.ibm.com/systems/support/storage/ssic/interoperability.wss).

IBM Fibre Channel Endpoint Security hardware requirements

IBM Fibre Channel Endpoint Security is an end-to-end solution that ensures the integrity and confidentiality of all data flowing on Fibre Channel links between an IBM z15 T01, a LinuxONE III LT1 server, or an IBM z16 family server, and a DS8900F within the data center, as the data moves between trusted entities.

The minimum hardware required is the following:

- Driver D41C bundle level as documented in IBM Support - Preventive Service Planning buckets, Upgrade 8561DEVICE, Subset 8561/ZVM (https://www.ibm.com/support/docview.wss?uid=isg1_8561DEVICE_8561-ZVM)
- FICON Express16SA Adapter for encryption support

- FICON Express16S+ Adapter for authentication support when a FICON Express16SA Adapter is also installed
- Endpoint Security Enablement
- CPACF enablement
- DS8900F enabled for Endpoint Security
- SAN hardware and software requirements and prerequisites required for support of IFCES can be found in IBM Resource Link Switches and Directors qualified for IBM Z FICON and FCP channels (https://www.ibm.com/servers/resourcelink/lib03020.nsf/pages/switchesAndDirectorsQualifiedForIbmSystemZRFiconRAndFcpChannels).

Device support

z/VM handles real devices as either supported or unsupported.

Supported devices

A supported device is one of those listed in Appendix C, "IBM devices supported by z/VM," on page 97. The use of such a device is fully supported by IBM through the service support available with z/VM. There are two types of device support:

- Supported for CP and guest use

  The device is attached to the system and can be used by CP and virtual machines. CP provides system services for the device, including error recovery for guest DIAGNOSE I/O requests, and a full command set (that is, you can use all of the device-oriented CP commands for the device). Such a device can also be shared among multiple guests if appropriate (as, for example, in the case of a DASD), or it can be dedicated to the exclusive use of a single guest.
- Supported for dedicated use by a single guest

  The device can be logically attached to only one guest virtual machine at any one time. The guest must be capable of running with the device. CP cannot use the device itself, and DIAGNOSE I/O services are not available to the guest for such a device.

Unsupported devices

In addition to the devices listed in Appendix C, "IBM devices supported by z/VM," on page 97, you can also connect other devices to z/VM if they are equivalent or similar to any of the supported devices. Such other devices are referred to as unsupported devices, and proper operation of such devices with z/VM and guest operating systems is your responsibility. IBM does not guarantee that unsupported devices run properly with z/VM, and service support for such device attachments is not supplied.

If a device is absolutely equivalent to a supported device, you can define it as such and use it in any way you would use the corresponding supported device. You are responsible for the determination of equivalence.

If a device is not equivalent to any supported device but is more or less similar to one, you can use the RDEVICE system configuration statement or the SET RDEVICE command to define it as an unsupported device. An unsupported device must be dedicated to a single guest; that is, an unsupported device cannot be a system-owned or CP-owned device.

Software (program) requirements

z/VM 7.4 has prerequisite licensed programs, and some z/VM facilities might have additional program requirements. These are described in the following topics:

- "Prerequisite licensed programs" on page 28
- "High Level Assembler" on page 28
- "Supported levels of z/VM base facilities and optional features" on page 29

Prerequisite licensed programs

z/VM 7.4 requires the following additional IBM licensed programs:

- **Device Support Facilities: ICKDSF for VM, V1.17 (5684-042) or later**

  Any fixes requested for ICKDSF should specify the PTF number of the VMSES/E formatted update. VMSES/E installable PTFs have the release number H14. 'H' indicates release 17 of ICKDSF and '14' indicates VMSES/E format.

  The following APARs are required:

  – APAR PI46151 provides support for the IBM z14 family or later servers.
  – APAR PI85943 provides support for extended address volume (EAV) minidisks.
  – APAR PH14249 provides a parameter to the CPVOLUME command to suppress progress messages.
  – APAR PH52513 removes the 64G restriction for PAGE allocation on an FBA volume.

  ICKDSF is preinstalled with z/VM. That is, it is included on the z/VM System Image and automatically installed. Therefore, when ordering z/VM, you must be licensed for this program or you must place an order for it to establish a license. Both the CMS version of ICKDSF and an IPLable stand-alone version (5747-DS1) are supplied with z/VM.

High Level Assembler

All IBM-provided assembler source code is intended to be assembled using the IBM High Level Assembler, V1.6 (5696-234) or later.

In some circumstances, the built-in ASSEMBLE command (called by the VMFASM EXEC) may be used to apply changes to product modules that contain configuration data intended to be modified by the customer.

Use of the High Level Assembler is required for the HCD IOCP import function.

The High Level Assembler has the following additional program requirements:

- APARs PI62275 and PI65715 provide support for new instructions provided with the IBM z14 family.
- APAR PH00902 provides support for new instructions provided with the IBM z15 family.
- APAR PH39324 provides support for new instructions provided with IBM z16 family.
- APAR PH62834 provides support for new instructions provided with the IBM z17 family.

Supported levels of z/VM base facilities and optional features

z/VM 7.4 supports the following base facilities and optional features. Previous levels of these facilities and features are not supported by z/VM 7.4. Additional PTFs for these facilities and features might be required to support some z/VM 7.4 functions.

- Base facilities:
  - HCD and HCM for z/VM, function level 740 (included with the z/VM 7.4 Command Program (CP))
  - Language Environment, function level 730 (preinstalled)

    This is equivalent to z/OS 2.5 Language Environment.
  - TCP/IP for z/VM, function level 740 (preinstalled)
- Optional features:
  - DFSMS/VM, function level 221 (available with the 7.4)
  - Directory Maintenance Facility for z/VM, function level 740 (preinstalled disabled)
  - Performance Toolkit for z/VM, function level 740 (preinstalled disabled)
  - RACF Security Server for z/VM, function level 740 (preinstalled disabled)
  - RSCS Networking for z/VM, function level 740 (preinstalled disabled)

z/VM base components additional program requirements

The z/VM base components have the following additional program requirements.

- To develop OpenExtensions (POSIX) applications on CMS, you need:
  - One of the following compiler programs, or an equivalent product:
    - IBM XL C/C++ for z/VM, V1.1 (5654-A22) or later
    - IBM C/C++ for z/VM, V1.1 (5654-A22)
    - IBM C for VM/ESA, V3.1 (5654-033)
  - Language Environment, level 730

DFSMS/VM additional program requirements

DFSMS/VM, function level 221, has the following additional program requirements:

- To use the Interactive Storage Management Facility (ISMF) functions:
  - Interactive System Production Facility (ISPF), V3.2 (5684-043) or later

    Note: ISPF is not required if you are using only the 3495 Tape Library Dataserver support of DFSMS/VM.
- To use the minidisk management functions:
  - Directory Maintenance Facility for z/VM, function level 740
- If an external security manager is needed for authorizations:
  - RACF Security Server for z/VM, function level 740, or an equivalent product
- To access the 3495 Tape Library Dataserver for servers capable of 3490/3490E tape I/O but incapable of 3495 Tape Library Data Server control:
  - TCP/IP for z/VM, function level 740
- For remote operations:
  - RSCS Networking for z/VM, function level 740
- If the compiled REXX installation-wide exit or a compiled ACS REXX exit is desired:
  - Compiler for SAA REXX/370 (5695-013)

  - Library for SAA REXX/370 (5695-014)
- Additional enhancements and support:
  - APAR VM63004 provides support for more than 10017 cylinders on an emulated 3390 Model 9 on System Storage DASD subsystems.
  - APAR VM63664 provides support for very large (near 1 TB) SCSI disks on the DS8000® and DS6000.
  - APAR VM63746 provides support for DFSMS/VM RMS to share tape drive devices using the MULTIUSER option of the CP ATTACH command. For example, this support allows z/VM 3590 install media to be inserted into, and z/VM to be installed from, an Automated Tape Library (ATL).
  - APAR VM64062 provides support for locating encryption-capable 3592 tape drives in an Enterprise Automated Tape Library. The DFSMS/VM support provides tape-encryption capabilities for a 21CS VSE^{n} guest running on z/VM.
  - APAR VM64458 provides support for the 3592 Model E06.
  - APAR VM65005 provides support for the 3592 Model E07.
  - APAR VM65789 provides Copy Export support.

DirMaint additional program requirements

Directory Maintenance Facility for z/VM, function level 740, has the following additional program requirements:

- To assemble DirMaint exit routines or tailorable files:
  - IBM High Level Assembler, V1.6 (5696-234) or later

HCD and HCM additional program requirements

There are no additional requirements for HCD and HCM when z/VM 7.4 is installed.

HCD and HCM support by z/VM version is documented for each IBM server model. See the following topics:

"Server support: IBM z17 family" on page 87
"Server support: IBM z16 family" on page 89
"Server support: IBM z15 family" on page 91
"Server support: IBM z14 family" on page 93

IOCP additional program requirements

There are no additional requirements for IOCP support when z/VM 7.4 is installed.

IOCP support by z/VM version is documented for each IBM server model. See the following topics:

"Server support: IBM z17 family" on page 87
"Server support: IBM z16 family" on page 89
"Server support: IBM z15 family" on page 91
"Server support: IBM z14 family" on page 93

Language Environment additional program requirements

Language Environment, function level 730, has the following additional programming requirements:

- To customize Language Environment, or to compile assembler routines included in mixed-language user applications:
  - IBM High Level Assembler, V1.6 (5696-234) or later

Performance Toolkit additional program requirements

Performance Toolkit for z/VM, function level 740, has the following additional program requirements:

- To generate Performance Toolkit graphics on the console of a virtual machine:
  - IBM Graphical Data Display Manager (GDDM)/VM, 5684-168

z/VM Performance Data Pump additional program requirements

z/VM Performance Data Pump can run in any CMS virtual machine that has sufficient privilege and resources.

Data Pump by itself does not deliver value that a user can readily use. To take advantage of Data Pump the customer must provision, configure, and deploy other services to process the data stream. While instructions for deploying the open source solutions are available, these components are not delivered with the z/VM product. For more information, see z/VM Performance Data Pump (https://www.vm.ibm.com/related/perfkit/datapump/).

Data Pump does not depend on function that is provided by Performance Toolkit.

Support for the z/VM Performance Data Pump power metric dashboard requires Performance Toolkit PTFs for APARs VM66826 (7.4) and VM66825 (7.3).

RACF additional program requirements

RACF Security Server for z/VM, function level 740, has no additional program requirements.

RSCS additional program requirements

The following additional program requirements are included with the z/VM 7.4 base:

- Group Control System (GCS) must be configured and activated.
- To communicate with users in an SNA network:
  - VTAM for VM/ESA, V4.2 (5654-010)
- To communicate within an IP network:
  - TCP/IP for z/VM, function level 740
  - SSL server for secure TCPNJE-type connections
- To assemble RSCS exit routines:
  - IBM High Level Assembler, V1.6 (5696-234) or later

Shared-DASD complex additional program requirements

In a non-SSI shared DASD complex, a single DirMaint server with a single source directory can manage the object directory on up to 56 z/VM systems, if the DirMaint executable code disks and source directory disk are shared among all the systems. The following is required to support the shared-DASD complex:

- DirMaint, function level 740

  Within the shared-DASD complex, all z/VM systems must be licensed for the DirMaint FL740 feature and must be running the same DirMaint service level.

SSI clusters additional program requirements

To create and manage a z/VM single system image (SSI) cluster, the following programs and additional support are required:

- Prerequisite service that must be installed on all members within an SSI cluster before any member of the cluster is IPLed on an IBM z17 family server.

  - z/VM 7.4 with the PTF for APAR VM66839, or z/VM 7.3 with the PTF for APAR VM66832, which provides infrastructure support for the IBM z17 family server.
- Directory Maintenance Facility, function level 740, or an equivalent product.
- If an external security manager is needed:
  - RACF Security Server for z/VM, function level 740, or an equivalent product

TCP/IP additional program requirements

TCP/IP for z/VM, function level 740, has the following additional program requirements:

- If an external security manager is needed:
  - RACF Security Server for z/VM, function level 740, or an equivalent product
- To develop programs in C:
  - One of the following compiler programs, or an equivalent product:
    - IBM XL C/C++ for z/VM, V1.1 (5654-A22) or later
    - IBM C/C++ for z/VM, V1.1 (5654-A22)
    - IBM C for VM/ESA, V3.1 (5654-033)
  - Language Environment, level 730
- To develop programs in Pascal:
  - IBM VS Pascal, V1.2 (5668-767), Compiler and Library, or an equivalent product

For more information about program requirements for TCP/IP for z/VM, see *z/VM: TCP/IP Planning and Customization*.

Program requirements for other products running on z/VM

- Linux on IBM Z

  Linux is not provided with z/VM. In order to operate Linux as a guest of z/VM, Linux must be obtained from a Linux distribution partner. For current information on Linux distributions, see Linux OS on IBM Z mainframe (https://www.ibm.com/it-infrastructure/z/os/linux).
- Other IBM licensed products might also have additional program requirements to run on z/VM 7.4. See the product documentation and the product websites. Also see IBM z/VM and VM-related licensed products and features (https://www.ibm.com/vm/related).
- z/VSE® has achieved end of life and has been replaced by 21CS VSE^n. Support for 21CS VSE^n is provided by 21CS. For more information, see Appendix B, “IBM Z–compatible operating systems supported as guests of z/VM ,” on page 95 and 21CS website.

Limitations

z/VM has the following limitations:

- Each z/VM release has an architecture level set (ALS) and operates only on specific IBM Z and LinuxONE servers. See Appendix A, “IBM servers supported by z/VM,” on page 85.
- z/VM supports General mode (on IBM z14 family and later servers), LINUX-only mode, and z/VM mode LPARs.
- z/VM may run on IFL processors only if, on the IFL processors, z/VM is being used exclusively to run:
  1. Linux workloads
  2. if required, z/VM applications in support of those Linux workloads
- Dynamically modified channel programs cannot run in a virtual machine unless the channel program modification facility that the DIAGNOSE interface provides can be used to ensure correct operation of such channel programs.

For z/VM system limits (maximum allowed values and minimum required values), see Appendix D, "z/VM system limits," on page 111.

Performance considerations

System performance depends on the hardware resources allocated to z/VM and on the level of activity within each guest. For more information, see IBM: VM Performance Resources (https://www.ibm.com/vm/perf/); in particular, you should closely review the z/VM 7.3 and earlier performance reports.

For assistance in understanding the performance implications for a particular situation, contact your IBM representative or your IBM Business Partner.

Operating systems supported as guests

See Appendix B, "IBM Z–compatible operating systems supported as guests of z/VM ," on page 95.

Other programs supported on z/VM

For information about other IBM licensed programs supported on z/VM, see IBM z/VM and VM-related licensed products and features (https://www.ibm.com/vm/related).

For information about non-IBM Solution Developer products that run on z/VM, see IBM: Non-IBM Solution Developer Information for z/VM (https://www.ibm.com/vm/vendor/).

Language support

These are the only currently supported languages:

Mixed-case American English (AMENG)
This is the system default language.

Uppercase English (UCENG)
You can choose to specify this as the default.

KANJI language files have been removed from base z/VM components.

Packaging and ordering information

To order z/VM 7.4, order the z/VM System Delivery Offering (SDO) 7.4, program number 5741-A10. The SDO is the IBM program offering for z/VM, which includes a single deliverable that contains the z/VM operating system and a group of fully-serviced IBM licensed programs.

z/VM 7.4 is available as an electronic image in ISO format. For more information, see IBM: VM System Delivery Offering (SDO) (https://www.ibm.com/vm/sdo).

The z/VM 7.4 system image contains:

- Prerequisite IBM licensed program:
  - ICKDSF for VM 1.17 (5684-042) (includes ICKDSF standalone release 17)
- The z/VM 7.4 base licensed program:
  - AVS
  - CMS
  - CP
  - Dump Viewing Facility
  - GCS
  - HCD and HCM for z/VM, function level 740
  - Language Environment, function level 730

  - REXX/VM
  - Single system image (SSI) function
  - TCP/IP for z/VM, function level 740 (includes source)
  - TSAF
  - VMSES/E
  - SFS and CRR file pools
  - DASD Dump Restore (DDR) program
  - Input/output configuration program (IOCP)
  - CP and CMS message repositories
  - Mixed-case and uppercase American English help files
  - 3800 printer image library object code
  - 3800 printer image library source
- z/VM optional features:
  - DirMaint, function level 740
  - Performance Toolkit for z/VM, function level 740
  - RACF Security Server for z/VM, function level 740
  - RSCS Networking for z/VM, function level 740

Notes:

1. ICKDSF is not part of the z/VM licensed program. It is a separate prerequisite IBM licensed program that is included in the z/VM System Image for convenience. Before using ICKDSF you must be licensed for it, or you must place an order for it to establish a license.
2. The DirMaint, Performance Toolkit, RACF, and RSCS optional features are included in the z/VM system image for convenience. They are installed disabled. If you decide to use any of these features, you must place orders for them to establish licenses so that you can enable them.
3. The DFSMS/VM optional feature is not included in the z/VM system image. If desired, DFSMS/VM must be ordered as a no-cost optional feature of z/VM.
4. z/VM 7.4 and 7.3 provide GETSHOPZ, an optional way to transfer service to your z/VM system. With this support, z/VM 7.4 and 7.3 provide a web interface that simplifies the downloading of z/VM service ordered through IBM Shopz. The service files can now be transferred through a direct-to-host connection. The data is verified and unpacked during the transfer to the z/VM host system.

   With the PTF for APAR VM66834, z/VM 7.4 provides GETSHOPZ support for direct-to-host transfer of service packages from IBM ServiceLink. Clients currently use the GETSHOPZ utility to securely transfer z/VM service packages directly from Shopz. This support provides the same ability for ServiceLink orders.

   For more information, see the *z/VM: Service Guide*.

Object code only and limited source availability

Some z/VM components, facilities, and features are distributed in object code only (OCO) form. No source program materials are available for the following:

- AVS
- Dump Viewing Facility
- DFSMS/VM
- Performance Toolkit

CP, CMS, DirMaint, and RACF are distributed partially in OCO form, which means that some modules will not have source program materials available but others will.

Integrity and security

This section discusses facilities of z/VM that deal with the integrity and security of the system.

Data integrity for guests

Operating system failures that occur in virtual machines do not normally affect z/VM running on the real processor. If the error is isolated to a virtual machine, only that virtual machine fails, and the user can re-IPL without affecting the work running in other virtual machines.

System integrity statement for z/VM

System integrity is an important characteristic of z/VM. IBM statements on system integrity extend to the z/VM environment. IBM has implemented specific design and coding guidelines for maintaining system integrity in the development of z/VM. IBM product development, including z/VM, follows the IBM Secure Engineering Framework for the secure design, development, coding, testing, service, and certification of its deliverables. For more information, see IBM Secure Engineering (https://www.ibm.com/security/secure-engineering/).

Because it is not possible to certify that any system has perfect integrity, IBM will accept APARs that describe exposures to the system integrity of z/VM or that describe problems encountered when a program running in a virtual machine not authorized by a mechanism under the customer's control introduces an exposure to the system integrity of z/VM. IBM will continue its efforts to enhance the integrity of z/VM and to respond promptly when exposures are identified in the specified operating environment on releases of z/VM that have not reached their End of Support Date, which can be found at IBM Support - Software lifecycle (https://www.ibm.com/software/support/lifecycle/index_z.html).

Note: IBM reserves the right to change, modify or withdraw its offerings, policies and practices at any time. All products and support obligations are subject to the terms of the applicable license and services agreements.

z/VM system integrity definition

Unless authorized by a z/VM control program (CP) mechanism under the customer's control or a guest operating system mechanism under the customer's control, a program running in a virtual machine cannot:

- Circumvent or disable the control program real or auxiliary storage protection.
- Access a resource protected by an external security manager (ESM), such as RACF. Some of the protected resources are virtual machines, minidisks, and terminals.
- Access a control program password-protected resource.
- Obtain control in real supervisor state or with privilege class authority or directory capabilities greater than those it was assigned.
- Circumvent the system integrity of any guest operating system that itself has system integrity as the result of an operation by any z/VM control program facility.

Real storage protection refers to the isolation of one virtual machine from another. CP accomplishes this by hardware dynamic address translation, start interpretive-execution guest storage extent limitation, and the Set Address Limit facility.

Auxiliary storage protection refers to the disk extent isolation implemented for minidisks and virtual disks through channel program translation.

Password-protected resource refers to a resource protected by CP logon passwords and minidisk passwords.

Privilege class authority refers to the authorization of a virtual machine to use specific IBM-defined or customer-defined classes of CP system functions.

Directory capabilities refer to those directory options that control functions intended to be restricted by specific assignment, such as those that permit system integrity controls to be bypassed or those not intended to be generally granted to users.

Guest operating system refers to a control program that operates under the z/VM control program.

Customer responsibilities

While protection of the customer's data remains the customer's responsibility, data security continues to be an area of vital importance to IBM. IBM is committed to continually improving the system integrity of the z/VM environment to help customers protect their data.

Product documentation, subject to change, describes the actions that must be taken and the facilities that must be restricted to complement the system integrity support provided by z/VM. Such actions and restrictions might vary depending on the system, configuration, or environment. The customer is responsible for the selection, application, adequacy, and implementation of these actions and restrictions, and for appropriate application controls.

DirMaint system integrity

DirMaint uses standard z/VM system facilities to:

- Protect the DirMaint service machines (DIRMAINT, DATAMOVE, DIRMSATs) from subversion
- Protect files from outside interference or contamination
- Isolate users from each other and from the system
- Exploit hardware protection mechanisms
- Identify the originating user ID (and node ID) for all incoming requests
- Record auditable information

Security, auditability, and control

z/VM includes several facilities to enhance or improve the security and integrity of the system:

- Each guest and CMS user runs in a unique virtual machine definition which, in combination with hardware features, prohibits one user from accessing another's data in storage (unless specifically allowed through shared segments, communication vehicles such as IUCV and APPC/VM, or ESA/XC and z/XC data sharing services).
- z/VM, in combination with hardware features, provides protection against channel programs accessing another user's virtual addresses.
- A password facility provides minidisk security to control both read-only and read-write access.
- Both user ID and password checking are provided to minimize unauthorized system access. User IDs and passwords (or similar authorization tokens) are validated at time of logon to prevent both unauthorized system access as well as credential phishing.
- Working together, z/VM and the optional RACF feature support the use of passwords longer than eight characters, called password phrases. When RACF is installed, either passwords or password phrases may contain mixed-case letters, numbers, blanks, and special characters.
- z/VM supports Multi-Factor Authentication (MFA), which provides for the establishment of a user's identity by utilizing more than one type of authentication. This provides greater security by allowing for an additional form of proof in the event that one token (for example, a password) becomes compromised. Previously, authentication of identity during the logon process could be met only by using a password or passphrase. MFA enables support for an external service to authenticate tokens that have been generated after a successful multi-factor authentication. MFA requires an exploiting External Security Manager (ESM).
- Privilege class modification provides customers with the ability to control access to commands and DIAGNOSE codes more precisely through customer-defined classes (role-based access controls).
- Journaling is supported on z/VM.

- Directory control statements and system configuration file statements provide controls for certain POSIX-related functions, such as the ability to change another virtual machine's POSIX security values.
- Authorizations for z/VM guest LANs and virtual switches can be handled by the RACF feature, or by any equivalent external security manager that supports this function.
- z/VM supports drive-based data encryption with IBM System Storage tape drives. z/VM supports native and guest use of the IBM Encryption Key Manager for encryption of tapes.
- z/VM supports the use of DASD volumes that reside on data encryption drives (DEDs).
- z/VM 7.3, with the PTF for APAR VM66732 applied, provides digital signature verification of z/VM service packages. This assures that the service package came from a trusted source (authenticity) and verifies that the package was not altered or otherwise tampered with in flight (integrity). Digital signature verification is in the base of z/VM 7.4.

The RACF feature provides customers with many of these facilities, as well as other security capabilities. Note that passwords or password phrases are encrypted only when an ESM such as RACF has been installed on your z/VM system.

Support for cryptographic facilities on IBM servers

z/VM supports guest use of the cryptographic facilities provided by IBM servers:

- Crypto Express adapters (specific devices depend on the server)

  Guest operating systems such as Linux on IBM Z and z/OS can be authorized to use cryptographic adapters in either of these ways:

  – Use of *dedicated* cryptographic adapters can be authorized either in the user's z/VM directory or via z/VM dynamic crypto support.
  – Use of *shared* cryptographic adapters can be authorized only in the user's z/VM directory.
- CP Assist for Cryptographic Functions (CPACF)

  Authorization is not required to use CPACF.

CMS file pool security

CMS file pools include the following features to aid data security for SFS data and BFS data stored in them:

- To access a file pool, you must be authorized (enrolled) by someone with administrator authority for that file pool, or PUBLIC must be enrolled.
- If an administrator gives you an SFS file space in a file pool, you are the only one (other than an administrator) who can create files in that file space, unless you specifically grant this authority to another user.
- You can control access to your SFS files and directories by granting and revoking authority to other users.
- Only the owner of an SFS directory or an administrator can delete the directory.
- Implicit and explicit locks prevent simultaneous updates.
- An auditing facility is available that documents:

  – Attempts to access file pool resources
  – Use of CRR recovery server operator commands and file pool server operator commands, which erase CRR and SFS log data in the intervention of CRR activity.

In addition, an external security manager (ESM), such as RACF Security Server for z/VM, can replace file pool authorizations for those objects protected by the ESM.

File pools can exploit ESM services through documented interfaces including the use of the RACROUTE programming interface.

User management is responsible for evaluation, selection and implementation of these features, for administrative procedures, and for appropriate controls in application systems and communications facilities.

TCP/IP security

TCP/IP for z/VM offers the following security facilities:

- Transport Layer Security (TLS) and Secure Sockets Layer (SSL) support

  TLS/SSL provides secure (encrypted) communication between a remote client and a TCP/IP application server. Under TLS protocol, the application server is always authenticated. To participate in a TLS session, an application server must provide a certificate signed by a certificate authority (CA) to prove its identity. The SSL protocol, and its associated encyption ciphers, are provided for legacy support purposes only; IBM strongly encourages the use of TLS 1.2 and SHA-256 (or stronger) certificates when using a secure connection.

  The z/VM 7.3 System SSL module and surrounding components have been designed to be FIPS 140-2 compliant. IBM intends to pursue an evaluation of the FIPS 140-3 using NIST Cryptographic Module Validation Program (CMVP) for the System SSL implementation delivered with z/VM 7.4.

  The z/VM TLS/SSL server also supports elliptic-curve cryptography (ECC) cipher suites. ECC provides a faster, more secure mechanism for asymmetric encryption than standard RSA or DSS algorithms.
- Exits to an ESM

  TCP/IP servers can be configured to use RACF Security Server for z/VM or another ESM to:

  – Authenticate and authorize access to resources managed by the server
  – Validate client user IDs and passwords
- LDAP server and client

  The Lightweight Directory Access Protocol (LDAP) server and associated client utilities provide user authentication, authorization, and auditing capabilities.

DirMaint security

DirMaint supports the z/VM security strategy:

- Access to user IDs is password controlled. DirMaint maintains user passwords, with customer choice of administration control or user control. DirMaint also supports the use of an ESM for password control.
- Access to minidisks is controlled by either passwords or explicit link authorization, as determined by the minidisk owner. Minidisk passwords are optional for controlling minidisk directory links. DirMaint also supports control of minidisk links by an ESM.
- z/VM system services are used to identify the originating user ID (and node ID) for all requests, whether local (those originating from within the scope of a single system or a multiple system cluster) or remote (those originating from beyond the local system cluster). By default, all local requests (whether standard or surrogate) are accepted from authorized users without additionally prompting for the correct logon password. However, unless prohibited by the system administrator, users may force local users to authenticate for each DirMaint transaction. Remote requests (surrogate or otherwise) never require authentication.
- All DirMaint commands involving the DirMaint service machines (DIRMAINT, DATAMOVE, DIRMSATs) are auditable. A few DirMaint commands (CHECK, DEFAULTS, EXECDROP, GLOBALV, HELP) are completely processed in the user's virtual machine, and are therefore not auditable by DirMaint. They may, however, be auditable by an ESM or some other security program.

  All messages generated by the DirMaint service machines are auditable.

  An exit routine will allow customers to tailor the filtering of unnecessary audit details.

Security provided by RACF Security Server for z/VM

RACF Security Server for z/VM provides additional comprehensive security capabilities. RACF controls user access to the system, checks authorization for use of system resources, and audits the use of system resources. RACF verifies logon passwords and password phrases and checks access to minidisks, data in spool files, SFS files and directories, and RSCS nodes.

You can use RACF commands to audit security-relevant events and prevent users from entering the CP DIAL and MSG commands before they log on. The events you can audit include:

- Any CP command or DIAGNOSE code (including privileged commands and DIAGNOSE codes)
- The creation, opening, and deletion of spool files
- The dumping and loading of spool files through SPXTAPE commands
- IUCV CONNECT and SEVER operations and certain VMCF functions
- APPC/VM CONNECT and SEVER operations
- The creation and deletion of logical devices.
- Connections to z/VM real devices (use of the CP ATTACH and GIVE commands).

For more information on logging and auditing, see *z/VM: RACF Security Server Auditor's Guide*.

Chapter 4. z/VM base product

The z/VM base product includes the following components and facilities:

Control Program (CP)

The z/VM Control Program (CP) is primarily a hypervisor and real-machine resource manager. CP provides each user with an individual working environment known as a *virtual machine*. Each virtual machine is a functional equivalent of a real system, sharing the real processor function, storage, console, and input/output (I/O) device resources.

When you first log on to z/VM, CP controls the working environment. Many of the facilities of z/VM are immediately available to you. For example, you can use CP commands to do various system management tasks. However, most of the work done on z/VM requires the Conversational Monitor System (CMS) or a guest operating system, such as Linux on IBM Z, to help with data processing tasks and to manage work flow.

CP provides connectivity support that allows application programs to exchange information with each other and to access resources residing on the same z/VM system or on different z/VM systems.

Virtual machine modes

z/VM supports the following virtual machine modes (architectures):

- **ESA** virtual machines process according to ESA/390 architecture (31-bit) or z/Architecture (64-bit). An ESA virtual machine is initially in ESA/390 architecture (31-bit) mode, but can be switched to z/Architecture (64-bit) mode by a guest operating system.
- **XA** virtual machines are supported for compatibility and are functionally equivalent to ESA virtual machines. Some CMS applications might require CMS to be running in an XA virtual machine.
- **XC** virtual machines process according to ESA/XC or z/XC architecture. An XC virtual machine is initially in ESA/XC architecture mode, but can be switched to z/XC architecture mode by a guest operating system.
- **Z** virtual machines process according to z/Architecture (64-bit) and cannot be switched to ESA/390 mode.

Notes:

1. Although 370-mode (IBM System/370 architecture) virtual machines are not supported, the 370 Accommodation Facility allows many CMS applications written for 370 virtual machines to run in ESA,

XA, and ESA/XC virtual machines. For more information about the 370 Accommodation Facility, see *z/VM: CP Programming Services*.

2. All z/VM virtual machines are type V=V (virtual=virtual), which means the virtual machine's guest real storage is paged into and out of host real storage.

Architecture compatibility and support

z/VM supports multiple architectures.

z/Architecture support

z/Architecture guests can use z/Architecture facilities in z/VM, such as 64-bit arithmetic and addressing. A guest in a Z virtual machine runs entirely in z/Architecture mode. A guest in an ESA or XA virtual machine can switch the virtual machine from ESA/390 mode to z/Architecture mode.

ESA/390 support

When an ESA or XA virtual machine is logged on, it will be put into either full ESA/390 mode or ESA/390-compatibility mode, depending on the level of ESA/390 capability available in the machine where the virtual machine is logged on or in the virtual machine's relocation domain. ESA/390-compatibility mode allows a subset of ESA/390 functionality sufficient for CMS and GCS, but lacks advanced functions like dynamic address translation (DAT).

Because ESA/390 architecture is upwardly compatible from ESA/370 architecture, and ESA/370 architecture is upwardly compatible from 370-XA architecture, in most cases an ESA/370 or 370-XA guest can run in an ESA/390 virtual machine. CP does not distinguish between the 370-XA, ESA/370, and ESA/390 architectures.

XC architecture support for virtual machines

z/VM uses extensions to the interpretive-execution facility to provide Extended Configuration (XC) virtual machine architecture. XC architectures are designed to provide services to application programs in virtual machines and are available only in MACHINE XC virtual machines.

XC architectures use VM data spaces. XC virtual machines can authorize other XC machines to share data spaces, which is extremely useful for applications that require one or more virtual machines to serve many users.

There are two versions of Extended Configuration architecture:

ESA/XC
Enterprise Systems Architecture/Extended Configuration (ESA/XC) is derived from and extends ESA/390 architecture.

z/XC
z/Architecture Extended Configuration (z/XC) is derived from and extends z/Architecture.

For more information, see *z/VM: ESA/XC Principles of Operation* and *z/VM: z/Architecture Extended Configuration (z/XC) Principles of Operation*.

Guest LANs and virtual switches

z/VM supports a network of virtual adapters connecting guests within a z/VM system:

- CP offers a virtual network interface card (NIC) that simulates either a HiperSockets device or an OSA-Express QDIO device. The guest can operate the virtual adapter using the same software that would be used to drive the equivalent hardware.

Restriction: The restriction described here has been lifted with the PTFs for APARs VM66877 (7.4) and VM66878 (7.3), and driver D61C Bundle #15:

  - A z/VM virtual switch that supports Network Express OSH does not currently support guests that exploit an EQDIO uplink port. In the interim, clients will be required to use either a guest-attached OSH device or existing functionality available with OSA-Express7S adapters.

- CP provides commands that enable z/VM users to connect virtual network adapters to an emulated local area network (LAN) segment, known as a guest LAN. Guests connected by a guest LAN can communicate using the same software that would be used to communicate over an equivalent physical LAN segment.

A guest LAN can be bridged through a z/VM virtual construct, known as a virtual switch, to an associated real LAN connected by an OSA-Express QDIO adapter or a Network Express EQDIO adapter. A virtual switch allows connectivity to external LAN segments without requiring a router.

In addition, a virtual switch can transparently bridge from a bridge-capable HiperSockets channel to a network connected by an OSA-Express (OSD) adapter or a Network Express (OSH) adapter.

For more information, see *z/VM: Connectivity*.

z/VM HiperDispatch

z/VM HiperDispatch can improve CPU efficiency by causing CP to run workload in a manner that recognizes and exploits IBM Z machine topology to increase the effectiveness of physical machine memory cache. This includes:

- Requesting the LPAR to handle the partition's logical processors in a manner that exploits physical machine topology
- Dispatching virtual servers in a manner that tends to reduce their movement within the partition's topology
- Dispatching multiprocessor virtual servers in a manner that tends to keep the server's virtual CPUs logically close to one another within the partition's topology

For more information, see *z/VM: CP Planning and Administration*.

Inter-System Facility for Communications

The Inter-System Facility for Communications (ISFC) enables channel-to-channel (CTC) communication between programs written to the APPC/VM, CPI Communications, or IUCV programming interfaces. A group of interconnected z/VM systems that use ISFC to communicate with each other is known as a communication services (CS) collection. Programs on systems in the CS collection can use ISFC to access, manage, and share resources defined in the collection. ISFC also enables programs in a CS collection to communicate with APPC programs on systems in the SNA network.

z/VM single system image function

The z/VM single system image (SSI) function enhances the z/VM systems management, communications, disk management, device mapping, virtual machine definition management, installation, and service functions to enable up to four z/VM systems to share and coordinate resources within an SSI cluster.

The member systems in an SSI cluster are part of the same ISFC collection and use ISFC channel connections to communicate. All members of a cluster also share DASD for virtual machines and selected z/VM data, as well as LAN segments and IP subnets. The concept of a global virtual switch provides identical network connectivity across all active members within a cluster.

Members of an SSI cluster are managed, serviced, and administered as one system. Resources used by both CP and virtual machines are shared among all members. These resources include:

- User directory
- Minidisks
- Spool files

- Network device MAC addresses

The combination of enhanced functions in the SSI cluster provides the foundation that enables live guest relocation, which is the capability for moving a running Linux guest from one system to another within the cluster. Live guest relocation provides continuity for virtual server workloads over planned z/VM and machine outages. Verification that needed resources and machine features are available on the destination system prior to the relocation is provided. This verification may also be performed on request to assess a guest's eligibility for relocation. In an SSI cluster comprising different machine models, the architecture level presented to each guest is tailored to the set of machine features common to the member systems within the guest's specified relocation domain.

For more information, see:

- "SSI clusters hardware requirements" on page 25
- "SSI clusters additional program requirements" on page 31
- *z/VM: CP Planning and Administration* for information on setting up SSI clusters

VM Dump Tool

The VM Dump Tool assists in analyzing dump data from a dump file created by the DUMPLOAD or DUMPLD2 utility. The VM Dump Tool provides a variety of subcommands and macros that allow you to display, locate, and format dump data interactively. This tool can process CP stand-alone dumps, CP abend dumps, and virtual machine dumps of a CP system. For more information, see *z/VM: VM Dump Tool*.

Note: The Dump Viewing Facility interactively diagnoses virtual machine dumps. See "Dump Viewing Facility" on page 58.

Support for hardware facilities, features, and architectures

This section lists *some* of the hardware facilities, features, and architectures that CP supports.

Notes:

1. Some support depends on hardware level and availability. For detailed information on hardware capabilities, requirements, and availability, see the appropriate IBM hardware announcements.
2. In some cases, the supported function is available only to guests.

Collaborative Memory Management Assist

CP support for the Collaborative Memory Management Assist (CMMA) machine feature, in conjunction with CMMA exploitation in z/Architecture guest operating systems such as Linux on IBM Z, allows the CP host and its guests to communicate attributes for specific 4 KB blocks of guest memory. This exchange of information allows both host and guest to optimize their use and management of memory. For more information, see *z/VM: Performance*.

CPU-Measurement Counter Facility

CP can collect counter data generated by the CPU-Measurement Counter Facility and include the counter data in the CP MONITOR data stream. Collection of the counter data can be enabled or disabled with the MONITOR SAMPLE command. IBM might request that a customer use MONITOR SAMPLE to collect counter data for problem analysis, benchmarking, or capacity planning purposes.

Cryptographic facilities

CP supports guest use of server cryptographic facilities (where available):

- Regional Crypto Enablement (RCE) adapters (on certain servers). RCE adapters are vendor products that provide country specific cryptographic functions. The RCE adapters are attached to the CEC via PCIe, and operating systems interact with the adapters via a HiperSockets network.
- Crypto Express5S or later adapters (depends on the server)

- CP Assist for Cryptographic Functions (CPACF), which supports high-performance bulk encryption using clear keys or encrypted keys.

z/VM provides clear key RSA support for a considerably large number of Linux guests, which helps to enable hardware SSL acceleration on the servers. Cryptographic operations for individual guests can be offloaded to Crypto Express hardware associated with the servers.

Dynamic Partition Manager (DPM) administrative mode for Linux

Dynamic Partition Manager (DPM), initially provided with IBM z13 family servers, supported configuring FCP SCSI storage. DPM enhancements that are provided by IBM z14 family servers with driver D32 bundle 55a support configuring FICON ECKD storage. Additional DPM enhancements that are provided by IBM z16 family servers with driver D51C bundle 28 further enhance DPM management support. The enhanced DPM support enables configuration of FICON Channel-to-Channel within the same CPC. A DPM-managed system can configure a z/VM SSI cluster within the same IBM z16 family server.

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

DPM mode provides simplified, consumable, and enhanced partition lifecycle and dynamic I/O management capabilities via the Hardware Management Console (HMC):

- Create and provision an environment, including the creation of new partitions, assignment of processors and memory, and configuration of I/O adapters (network, storage, crypto, and accelerators).
- Manage the environment by modifying system resources without disrupting running workloads.
- Monitor and troubleshoot the environment to identify the source of system failures, conditions, states, or events that may lead to workload degradation.

Dynamic storage reconfiguration

The dynamic storage reconfiguration (DSR) capability of the server allows the amount of main storage available for use in an LPAR to be changed while the LPAR is active. z/VM exploits this system architecture for its own use and also virtualizes it for guest use. LPAR customization can assign storage to an LPAR as initial or reserved. The reserved storage in the LPAR is further separated by z/VM into standby and reserved. z/VM can dynamically change, increase or decrease, the size of its main storage by changing the amount of online standby storage. z/VM guests that support DSR can also dynamically increase or decrease their amounts of main storage.

Enhanced Dynamic Address Translation (Enhanced-DAT)

The enhanced-DAT facility allows a guest to exploit large (1 MB) pages. A larger page size decreases the amount of guest memory needed for dynamic address translation (DAT) tables and also decreases the overhead required to perform address translation. In all cases, guest memory is mapped into 4 KB pages at the host level.

With guest large page support, Linux on IBM Z, 21CS VSE^{n}, and z/OS virtual machines can benefit from reduced memory footprints and address translation times. This can decrease overhead and improve throughput.

Environment information interface

The Store Hypervisor Information (STHYI) instruction can be used to access certain system information, including current CPU utilization and resources available at the machine, logical partition, hypervisor, and guest levels, as well as any caps (such as resource pools) that restrict the guest's use of these resources. This information enables an application to determine the maximum capacity of CP, zIIPs, and IFL CPUs available to software. In addition, STHYI supports reporting zIIP capacity information, which is necessary for IBM License Management Tool (ILMT) support for z/OS zCX guests.

ESA/390-Compatibility facility

z/Architecture-only servers do not support the full ESA/390 architectural mode. However, the ESA/390-Compatibility facility on a z/Architecture-only server provides ESA/390-compatibility mode, an environment supporting a subset of DAT-off ESA/390 applications in a hybrid architectural mode. z/VM provides the support necessary for DAT-off guests to run in this compatibility mode, which allows guests such as CMS, GCS, and those that start in ESA/390 mode briefly before switching to z/Architecture mode to continue to run on the z/Architecture server.

Extended Channel Measurement Data Support

Extended Channel Measurement Data Support (ECMDS) provides an extended I/O-measurement block for each subchannel and an extended measurement word at the completion of each I/O operation.

Extended-TOD-Clock Facility

The Extended-TOD-Clock Facility is a hardware facility that provides a 128-bit time-of-day (TOD) clock. CP supports the use of the Extended-TOD-Clock Facility from virtual machines.

Extent Space Efficient (ESE) DASD volumes

z/VM provides host recognition and guest exploitation support for Extent Space Efficient (ESE) thin provisioned DASD volumes. ESE volumes provide capabilities similar to Track Space Efficient (TSE) volumes, but are managed via the extent size that exactly matches the internal space allocation algorithms of the IBM DS8000. Guest (Linux) recognition of ESE capability and exploitation of space release functionality is provided for full pack minidisk, 1-END minidisk and dedicated DASD devices. The z/VM RELSPACE command is available to release all previously allocated space on a specified virtual device. The restriction that CPOWNED volumes cannot be defined on thin provisioned volumes has been removed.

Fibre Channel Protocol

The Fibre Channel Protocol (FCP) hardware channel allows a server to connect to a fibre-channel (FC) fabric. This support allows z/VM system facilities and guest operating systems to access selected devices on small computer system interface (SCSI) controllers connected to the fabric.

Fibre Connection channels

Fibre Connection (FICON) is a fiber optic I/O architecture that coexists with ESCON equipment and infrastructure, but offers improved link performance and enhanced distance connectivity. Each FICON channel provides the equivalent of eight ESCON channels.

-
- A FICON Express8 or Express8S channel is designed to deliver up to 8 Gbps.
- A FICON Express16S or Express16A channel is designed to deliver up to 16 Gbps.
- A FICON Express32S channel is designed to deliver up to 32 Gbps.

FICON Channel-to-Channel Adapter

CP supports guest use of the FICON Channel-to-Channel Adapter (FICON CTCA), which provides channel-to-channel communications between servers. This enables more reliable and higher bandwidth host-to-host communication than is available with ESCON channels.

FlashCopy

A native CP user or a guest can initiate the FlashCopy® feature on IBM System Storage and IBM TotalStorage DASD subsystems to make an instant copy of a disk or data set from a source device to a target device. CP also supports certain FlashCopy Version 2 functions, which provide additional flexibility.

z/VM supports the FlashCopy Space-Efficient feature of the DS8000 by providing space-efficient volumes for temporary data duplication for backup or test provision scenarios, while minimizing the amount of required backing storage to accomplish these tasks.

Guest ASCII console

z/VM provides guest access to the system ASCII console, which is a facility presented by the Hardware Management Console (HMC). Dedicating the system ASCII console to a Linux guest can facilitate recovery of the guest during an emergency situation, using an environment that provides tools (such as vi and emacs) that are familiar to Linux support staff. This can be particularly useful when normal network access to a guest operating system is not available. Use of the console can be transferred from guest to guest as required.

High Performance FICON for IBM Z

z/VM provides guest support for High Performance FICON for IBM Z (zHPF). zHPF is a performance and reliability, availability, serviceability (RAS) enhancement of the z/Architecture and the FICON channel architecture implemented in the supported servers and the System Storage DS8000 series. See "zHPF guest support hardware requirements" on page 26.

z/VM 7.4 and 7.3 provide enhancements allowing guests to exploit High Performance FICON (zHPF) on non-fullpack minidisks.

Exploitation of zHPF by the FICON channel, the operating system, and the control unit is designed to help reduce the FICON channel overhead. zHPF channel programs can be especially useful for I/O workloads that transfer small (4 KB) blocks of fixed-sized data. The supported FICON Express adapters support the FICON architecture, FICON channel-to-channel (CTC), and the zHPF architecture simultaneously.

HiperSockets

CP supports the z/Architecture HiperSockets function for high-speed TCP/IP communication among virtual machines and logical partitions (LPARs) within the same central processor complex. This function uses an adaptation of the queued direct I/O (QDIO) architecture.

CP supports HiperSockets for use by guest operating systems and by the z/VM TCP/IP server virtual machine. z/VM programs using traditional TCP/IP socket connections can communicate through HiperSockets with other z/VM programs, guest operating systems, and other logical partitions that are also using TCP/IP.

In addition, a z/VM virtual switch can transparently bridge from a bridge-capable HiperSockets channel to a network connected by an OSA (OSD) adapter.

HiperSockets channels can be defined as spanning channels, which can allow them to be configured as part of multiple logical channel subsystems and to be transparently shared among any subset or all of the configured logical partitions. For example, spanned HiperSockets channels can help enable communication among Linux guests running on z/VM images in different logical partitions, when the z/VM images are using different logical channel subsystems.

HyperPAV

z/VM exploits the ability for an IBM DS8000 device to issue concurrent I/O requests to an ECKD paging volume. In HyperPAV mode, if the base volume is busy, z/VM selects a free alias device from a pool, binds the alias to the base device, and starts the I/O. When the I/O completes, the alias device is returned to the pool to be used for another I/O to the same logical subsystem (LSS).

The primary benefit of exploiting HyperPAV is to improve paging throughput during periods of high-volume disk I/O, which will increase the efficiency of the z/VM frame replenishment algorithm used to manage storage overcommitted workloads. HyperPAV paging also enables the management of fewer and larger CPOWNED volumes.

HyperPAV paging is exploited by the z/VM hypervisor for:

- The SYSRES volume, and volumes containing checkpoint and warm start data
- Volumes used for paging, spooling, and the z/VM user directory
- Minidisk pools, as defined by a guest's use of the MAPMDISK IDENTIFY macro

IEEE Floating Point

CP supports guest use of the IEEE Floating Point hardware. This support allows multiple levels of guests to use basic floating point extensions, floating point support extensions, hexadecimal floating point extensions, and binary floating point.

Integrated 3270 console

CP supports this device, which is provided through a Hardware Management Console, to be used as the system operator console for installing and maintaining z/VM.

Logical channel subsystem

The logical channel subsystem (LCSS) structure on the server allows the definition of more than one channel subsystem, providing channel-path and subchannel controls for configuring channel-subsystem images. Each channel-subsystem image can be configured with up to 256 channel paths, and each logical partition has access to one channel-subsystem image. z/VM dynamic-I/O configuration allows channel paths, control units, and devices to be dynamically added, changed, and deleted in multiple LCSSs when z/VM is running on a server with the applicable hardware support.

LPAR group absolute capacity capping

This function allows an absolute capacity cap to be set by CPU type on a group of LPARs. This allows each of the partitions to consume capacity up to their individual limits as long as the group's aggregate consumption does not exceed the group absolute capacity limit. The z/VM support includes use of this information in functions that exploit or report processor capacity information for the purpose of tolerating its use.

MIDAWs

z/VM supports guest use of Modified Indirect Data Address Words (MIDAWs). This server feature can allow more flexibility and performance in certain channel programs as an alternative to data-chained channel-command words (CCWs). MIDAWs accommodate noncontiguous data areas that cannot be handled by the predecessor indirect-data-address words (IDAWs). z/VM support for guest use of MIDAWs can allow operating systems such as z/OS to use this new aspect of z/Architecture without regard to whether the operating systems are running in a logical partition or a virtual machine. This allows guest operating systems to exercise their code-paths just as they would on the real machine during, for example, preproduction testing of z/OS systems. Likewise, the provision of the function in a virtual machine allows guest operating systems to benefit from the real machine's added-value function just as though the guests were running directly on the machine.

Move-Page Facility

CP supports the Move-Page Facility for ESA/XC, z/Architecture, and z/XC guests. A page of data can be moved from main storage to main storage.

N_Port ID virtualization

N_Port ID virtualization (NPIV) for FCP channels is designed to allow the sharing of a single physical FCP channel among multiple operating-system images, whether in LPARs or as z/VM guests in virtual machines. z/VM exploits this hardware capability to define multiple virtual FCP channels, each with its own worldwide-unique Fibre Channel port name (WWPN). By assigning different hardware-defined virtual port names to different guests, the guests can use the virtual FCP channels as if they were dedicated physical FCP channels.

NPIV is applicable to all of the FICON adapters supported on the server. NPIV is supported for CP and guest use.

Network connectivity

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

Open Systems Adapter

CP supports guest use of the Open Systems Adapter (OSA) features for IBM Z servers. OSA features provide connectivity to various types of networks.

CP also supports:

- OSA-Express Integrated Console Controller (OSA-ICC), a function of the OSA-Express Ethernet adapter (OSA-Express4 and later) that integrates 3270 emulation for console session connections into the server.
- Virtual-switch-controlled link aggregation (IEEE 802.3ad), which allows you to dedicate an OSD or OSH port to z/VM when the port is participating in an aggregated group. Link aggregation (trunking) is designed to allow you to combine multiple physical OSA-Express ports (CHPID type OSD, OSA-Express4 and later) or Network Express ports (CHPID type OSH) into a single logical link for increased throughput and for nondisruptive failover in the event that a port becomes unavailable.

  Restriction: The restriction described here has been lifted with the PTFs for APARs VM66877 (7.4) and VM66878 (7.3), and driver D61C Bundle #15:

  – A z/VM virtual switch that supports Network Express OSH does not currently support guests that exploit an EQDIO uplink port. In the interim, clients are required to use either a guest-attached OSH device or existing functionality that is available with OSA-Express7S adapters.

  Note: The following special considerations apply to a CHPID that is defined with the LINK_AGGREGATION parameter for Network Express (OSH) devices.

  The LINK_AGGREGATION parameter on the DEFINE CHPID command, or the corresponding CHPARM in the IOCP (x02), indicates that the specified CHPID is to be used only for link aggregation. When the CHPID is defined in link aggregation mode, the device can be used only as part of a port group for z/VM virtual switch link aggregation. When the CHPID is not defined in link aggregation mode, attempts to bring up a z/VM virtual switch that is configured to use the device as part of a link aggregation port group will fail if either of the following conditions are true:

  – A NETH device is also configured on the port.

  – The system is managed by IBM Dynamic Partition Manager.
- Port isolation security, which provides the ability to restrict guest-to-guest communications within a virtual switch, and OSA-Express QDIO or Network Express EQDIO data connection isolation, which provides the ability to isolate QDIO and EQDIO data connection communications on a shared OSA port in support of multitier security zones.

To customize the modes of operation of OSA features, use OSA/SF on the Hardware Management Console (HMC).

Parallel Access Volumes

CP provides guest support for the Parallel Access Volumes (PAV) feature on IBM DASD subsystems, which allows configuration of base and alias DASD volumes. The alias volumes are logical volumes that map the physical space occupied by the base. However, each alias volume has a unique subchannel ID, which permits concurrent I/O to a base volume and all of its associated alias volumes.

PAVs enable a single server and applicable storage controllers to simultaneously process multiple I/O operations to the same logical volume, which can help to significantly improve I/O response times by reducing device queueing delays.

CP supports PAVs as linkable minidisks for guests such as z/OS that exploit the PAV architecture. In addition, CP provides the potential benefit of PAVs for I/O issued to minidisks owned or shared by guests that do not support native exploitation of PAVs, such as CMS.

CP also provides guest support for the HyperPAV function, which potentially reduces the number of alias-device addresses needed for parallel I/O operations, because HyperPAVs are dynamically bound to a base device for each I/O operation instead of being bound statically like basic PAVs. CP supports HyperPAVs as linkable minidisks for guests, such as z/OS, that exploit the HyperPAV architecture. In addition, CP transparently provides the potential benefit of HyperPAVs for I/O issued to minidisks owned or shared by guests that do not specifically exploit HyperPAVs, such as Linux and CMS.

Peer-to-Peer Remote Copy

CP supports the Peer-to-Peer Remote Copy (PPRC) feature on System Storage and TotalStorage DASD subsystems, a synchronous copy option that provides realtime mirroring of logical volumes within a device or to another device.

CP supports guest use of the PPRC Extended Distance (PPRC-XD) feature if the guest also supports PPRC-XD. PPRC-XD is an asynchronous copy option that can operate at distances well beyond the capability of PPRC. Native z/VM support for PPRC-XD is provided by ICKDSF, V1.17, with ICKDSF running in a CMS virtual machine.

CP also supports guest use of PPRC Version 2, including the Continuous Protection Option, which can offer an Asynchronous Cascading solution. Asynchronous Cascading provides a two-volume synchronous PPRC implementation with a non-synchronous third volume serving as a remote backup device that can provide a multisite, long distance solution.

Peripheral Component Interconnect Express (PCIe)

CP allows guests to dedicate Peripheral Component Interconnect® Express (PCIe) functions to their virtual machines.

- IBM Adapter for NVMe

  This feature supports the NVMe (non-volatile memory express) communications protocol by allowing a client-procured SSD (solid-state drive) storage device to be directly connected to the I/O subsystem through an IBM PCIe adapter.
- IBM zEnterprise Data Compression (zEDC) Express adapter

  The IBM zEDC Express adapter supports a data compression function that can provide high-performance, low-latency compression without significant CPU overhead. Starting with the IBM z15 family servers, IBM zEDC Express was replaced with on-chip data compression support.
- IBM RoCE Adapters (10GbE and 25GbE)

  The term RoCE refers to Remote Direct Memory Access over Converged Ethernet. The IBM RoCE Express adapter can reduce consumption of CPU resources for applications utilizing the TCP/IP stack (such as WebSphere Application Server accessing a Db2® database). Use of the RoCE Express adapter can help reduce network latency with memory-to-memory transfers for guests that support Shared Memory Communications-Remote Direct Memory Access (SMC-R). It is transparent to applications and can be used for LPAR-to-LPAR communication on a single system or server-to-server communication in a multiple-CPC environment.

CP also supports guest usage of virtual PCIe functions (PCI type ISM), which use Shared Memory Communications-Direct (SMC-D) connectivity.

Queued Direct I/O

CP supports guest use of Queued Direct I/O (QDIO), which allows a program to directly exchange data with an I/O device without performing traditional I/O instructions. To exchange data, both the I/O device and the program reference main storage directly through a set of data queues.

The QDIO architecture is used by OSA-Express, HiperSockets, and FCP channels.

In HiperSockets, the QDIO architecture includes a type of high-performance I/O interruption known as an adapter interruption. Adapter interruptions are also used by OSA-Express and FCP channels.

In addition, the server can provide a performance assist for the virtualization of adapter interruptions being given to guest operating systems running on z/VM. This hardware performance assist can be used by guests that support QDIO.

The server also provides QDIO Enhanced Buffer-State Management (QEBSM) and Host Page-Management Assist (HPMA), which can allow a cooperating guest operating system to initiate QDIO operations directly to the applicable channel, without interception by z/VM, thereby helping to provide additional performance improvements.

SAN Volume Controller

The IBM System Storage SAN Volume Controller is implemented in the storage network between the hosts and the physical storage, providing a common volume-management "utility" shared by all hosts. z/VM supports the SAN Volume Controller through the generic SCSI device driver of z/VM. z/VM support for the SAN Volume Controller allows CP and guest operating systems that use SCSI devices (such as Linux on IBM Z) to access IBM System Storage disk subsystems, as well as disk subsystems from other manufacturers supported by the SAN Volume Controller. The SAN Volume Controller can be used to provide SCSI devices as emulated FBA devices for use by CP and guest operating systems. Guests can also use SCSI devices accessed through the SAN Volume Controller by dedicated FCP subchannels.

Server Time Protocol

z/VM exploits the Server Time Protocol (STP) facility to generate time stamps for guest and system DASD write I/O operations, allowing these I/O operations to be synchronized with those of other systems. This support allows data used by z/VM and its guests to be replicated asynchronously over long distances by IBM System Storage z/OS Global Mirror (formerly known as Extended Remote Copy, or XRC). For example, this allows z/VM to participate in a GDPS® Metro Global - XRC (GDPS/MzGM) environment.

Shared Memory Communications - Direct Memory Access (SMC-D)

This networking technology provides support for fast, low-latency LPAR-to-LPAR TCP/IP traffic using SMC-D software protocol over firmware-provided Internal Shared Memory (ISM) devices.

SMC-D and ISM are designed to use shared memory areas to provide low-latency, high-bandwidth, cross-LPAR connections for applications. This support is intended to provide application-transparent DMA communications to TCP endpoints for sockets-based connections. SMC-D is expected to provide substantial performance, throughput, response time, and CPU consumption benefits compared with standard TCP/IP communications over HiperSockets. z/VM supports dynamic I/O and guest use of the new Internal Shared Memory (ISM) PCI function type.

Simultaneous multithreading (SMT)

Intelligently implemented simultaneous multithreading (SMT) allows two active instruction streams per core, each dynamically sharing the core's execution resources. SMT is available for workloads running on IFL and zIIP.

z/VM provides host exploitation support for SMT, which enables z/VM to dispatch work on up to two threads (logical CPUs) of an IFL processor core. z/VM multithreading support is enabled only for IFL processors in a LINUX only mode or z/VM mode logical partition.

z/VM exploitation of SMT enables z/VM to dispatch work on an individual thread of an IFL core, allowing a core to be shared by multiple guest CPUs or z/VM Control Program tasks. This can result in increased work throughput per core from more efficient use of shared core resources.

Multithreading support is available on a z/VM system only if the facility is available on the hardware and enabled on the z/VM system with the MULTITHREADING system configuration statement. The MULTITHREADING statement is optional, and multithreading is disabled if the statement is omitted.

If multithreading is enabled, the SET MULTITHREAD command can be used to nondisruptively switch between one and two activated threads per IFL core. Performance of a system and workload with one active thread per core is comparable to that of the same system and workload with multithreading disabled. Thus, the dynamic SMT level capability allows the benefit of multithreading to be evaluated for a workload without requiring an outage to enable or disable SMT.

z/VM enablement of multithreading requires that z/VM is configured to run with the HiperDispatch vertical polarization mode enabled and with the dispatcher work distribution mode set for reshuffle. Once enabled, multithreading cannot be disabled without a re-IPL. Dedication of virtual CPUs to z/VM processors is not supported with multithreading because it is not allowed when HiperDispatch vertical polarization mode is active.

When multithreading is enabled, prorated core time is used in the pool limiting calculation for all resource pools and in the consumption limiting calculation for a virtual machine being consumption limited. If multithreading is not enabled, raw CPU time is used instead. For an explanation of the three measures of CPU time, see *z/VM: Performance*.

z/VM host multithreading exploitation support does not virtualize threads for guest exploitation. However, Linux guests might benefit from the host support because the first level z/VM system is able to get higher throughput from the multithreaded IFL cores.

Specialty processors

z/VM provides guest support for IBM mainframe specialty processors:

IBM Integrated Facility for Linux (IFL)
IFL processors provide additional processing capacity for Linux workloads. IFLs can be allocated only in a LINUX only or z/VM mode LPAR.

IBM Internal Coupling Facility (ICF)
ICF processors allow multiple LPARs running z/OS to manage data and distribute workload in a Parallel Sysplex® clustered system.

IBM z Integrated Information Processor (zIIP)
zIIPs are designed to help improve resource optimization and lower the cost for eligible workloads. z/OS exploits zIIPs to offload software system overhead from standard central processors (CPs). This includes certain Db2 processing, enhancing the role of the mainframe as the data hub of the enterprise.

You can define a mix of these specialty processors and CPs in the same z/VM-mode logical partition.

z/VM provides two types of guest support for specialty processors:

- Simulation support

  z/VM guest virtual machines can create virtual specialty processors on processor models that support the same types of specialty processor but do not necessarily have them installed. Virtual specialty processors are dispatched on real CPs. Simulating specialty processors provides a test platform for z/VM guests to exploit mixed-processor configurations. For example, this allows users to assess the operational and CPU utilization implications of configuring a z/OS system with zIIPs without requiring the real specialty processor hardware.
- Virtualization support

z/VM can create virtual specialty processors for virtual machines by dispatching the virtual processors on corresponding specialty processors of the same type in the real configuration. For example, guest support for zIIPs might help improve your total cost of ownership by allowing available zIIP capacity not being used by z/OS LPARs to be allocated to a z/VM LPAR hosting z/OS guests running Java™ and Db2.

Note: z/VM will not allow a guest to define a processor type if the machine does not support it.

For more information about specialty processor support, see *z/VM: Running Guest Operating Systems*.

Transactional execution facility

z/VM supports guest exploitation of the transactional execution (TX) facility on supported processors. The TX facility allows a program to issue multiple instructions that appear to operate atomically, offering an alternative to more costly mutual-exclusion mechanisms such as software locks. This support can improve the efficiency and scalability of multithreaded software such as Java or guest operating system functions.

The IBM z17 family is planned to be the last IBM Z hardware generation to support constrained transactional execution (CTX). In subsequent IBM Z hardware generations, the TBEGINC instruction that is used to start a constrained transaction will receive an operation exception, and no constrained transactional execution will be initiated or supported.

Note that support for non-constrained transactional execution is reduced starting with the IBM z17 family. Starting with the IBM z17 family, the TBEGIN instruction used to start a non-constrained transaction will always complete with condition code 1 and with no transactional execution initiated, requiring the program to use its required "fallback path" for execution.

Vector Facility for z/Architecture (SIMD)

z/VM supports guest exploitation of the Vector Facility for z/Architecture (SIMD). This support enables guest use of Vector-Facility instructions and the 128-bit vector registers used by these instructions. This support also enables the use of the additional floating-point (AFP) registers for a guest at logon time. As a result, any output that includes floating-point registers will report all 16 floating-point registers when they are available to the user.

Virtual machine I/O assist

CP supports the virtual machine I/O assist facility for guests, which forwards an adapter interruption to a guest while the CPU keeps running in guest state. The virtual machine I/O assist can be enabled or disabled for all guests or specific guests.

APPC/VM VTAM Support (AVS)

APPC/VM VTAM Support (AVS) is a Virtual Telecommunications Access Method (VTAM) application that provides advanced program-to-program communication (APPC) services between z/VM and non-z/VM systems in an SNA network. AVS and VTAM run in the same GCS group on a z/VM system. Together, AVS and VTAM enable APPC/VM application programs in a TSAF or CS collection to communicate with:

- Other APPC/VM applications residing in other z/VM systems within the SNA network
- APPC applications residing in non-z/VM systems in the SNA network

For more information, see *z/VM: Connectivity*.

Conversational Monitor System (CMS)

The z/VM Conversational Monitor System (CMS) provides a high-capacity application environment that can support large numbers of interactive users. CMS can help you perform a wide variety of tasks:

- Write, test, and debug application programs for use on CMS or guest systems
- Run application programs developed on CMS or guest systems

- Create and edit data files
- Process jobs in batch mode
- Share data between CMS and guest systems
- Communicate with other system users

For general information about using CMS, see *z/VM: CMS User's Guide*.

Versions of CMS

z/VM provides two versions of CMS:

- ESA/390 CMS (CMS)

  ESA/390 CMS runs in an ESA/390 architecture (ESA or XA mode) or ESA/XC architecture (XC mode) virtual machine.

  ESA/390 CMS is supplied as a predefined named saved system called CMS and as an IPLable nucleus on the MAINT 190 minidisk.

- z/Architecture CMS (z/CMS)

  z/CMS runs in z/Architecture 31-bit addressing mode in an ESA, XA, XC, or Z virtual machine. z/CMS enables CMS programs to use z/Architecture instructions, including those that operate on 64-bit registers, while permitting existing ESA/390 architecture CMS programs to continue to function without change. Although it does not directly exploit storage above 2047 MB, z/CMS can be IPLed in a virtual machine with more than 2 GB of storage, and programs running on z/CMS can allocate storage above 2 GB.

  z/CMS is supplied as a predefined named saved system called ZCMS and as an IPLable nucleus on the MAINT 990 minidisk.

  For more information about z/CMS, see *z/VM: CMS Planning and Administration*.

Unless otherwise indicated in the z/VM publications, "CMS" means either version, and descriptions of CMS functions apply to both ESA/390 CMS and z/CMS.

Shared File System

The Shared File System (SFS) is an extension of the CMS file system that offers additional file management and file sharing functions:

- Files are stored in file pools.
- A user can be given an amount of file space in a file pool.
- The files in a file space are organized in directories.
- A file can be placed in more than one directory.
- Users can grant each other authorities on files or directories.
- Multiple users can have concurrent access to the same file or directory.
- Locks on files and directories ensure data integrity among multiple users.
- Files and directories can be shared with users on other systems.

A file pool is a collection of minidisks assigned to a single virtual machine called a *file pool server machine*. Because the minidisks in the file pool are shared by many users, using SFS can save DASD space. Certain SFS directories can be placed into VM data spaces, providing an additional DASD savings. Using VM data spaces might also provide a performance improvement.

For more information, see:

- “CMS file pool security” on page 37
- *z/VM: CMS File Pool Planning, Administration, and Operation*

For information about how DFSMS/VM can provide storage management functions for file pools, see "Data Facility Storage Management Subsystem for z/VM (DFSMS/VM)" on page 63.

CMS application programming

CMS supports a wide range of high-level languages and application environments. CMS also provides many special application programming facilities, including:

- Architectures supported:
  - ESA/XC
  - z/XC
- Assembler macros and functions
- Callable services library (CSL)
- CMS Pipelines
- DOS/VSE support

  Note: Although IBM VSE/VSAM, 6.1 (5686-081), was withdrawn from marketing on September 30, 2005, CMS DOS/BAM will continue to provide its current level of function in support of DOS simulation and VSE/VSAM.
- Multitasking services
- OpenExtensions (POSIX)
- OS/MVS simulation
- Program Management Binder
- Reusable Server Kernel
- Systems management APIs

For general information about CMS application programming facilities, see *z/VM: CMS Application Development Guide*.

Systems management application programming interface

The z/VM systems management application programming interface (SMAPI) provides a standard, platform-independent client interface that reduces the amount of VM-specific programming skills required to manage resources for virtual systems (guests). SMAPI includes functions for creating new virtual images, allocating and managing their resources, and changing their configurations. The functions can be used to activate and deactivate images individually or in groups. Security and directory management functions are also provided. The SMAPI functions are invoked by a client through a sockets interface.

For more information, see *z/VM: Systems Management Application Programming*.

CMS Pipelines

CMS Pipelines provides a rich and efficient set of functions that you can use to solve large problems by breaking them up into smaller, less complex programs. These smaller programs are called *stages*. Many stages are included with CMS Pipelines. Some stages read data from system sources, such as disk files, tape files, or the results of z/VM commands. Other stages filter and refine that data in some way. You can combine many stages within a single *pipeline* to create the results you need. You can also write your own stages. For more information, see *z/VM: CMS Pipelines User's Guide and Reference*.

CMS application multitasking

CMS application multitasking services provide an execution environment for high-performance applications and servers. With CMS multitasking, an application can divide itself into multiple units of execution and provide the ability for these units, called threads, to run on multiple CPUs simultaneously. The multitasking facilities are available only at the application programming level. The CMS user still

runs one application at a time, but these applications can split themselves into multiple execution units, or threads. These multitasking facilities allow applications to harness the power of the underlying multiprocessor complex and to overlap operations to achieve high performance. For more information, see *z/VM: CMS Application Multitasking*.

OpenExtensions

The CMS OpenExtensions environment includes the z/VM implementation of four POSIX standards:

- POSIX 1003.1 (known as POSIX.1) - System Interfaces
- POSIX 1003.1a (known as POSIX.1a) - Extensions to POSIX.1
- POSIX 1003.1c (known as POSIX.1c) - Threads
- POSIX 1003.2 (known as POSIX.2) - Shell and Utilities

The POSIX.1, POSIX.1a, and POSIX.1c interfaces are provided as C/C++ library routines in the C/C++ runtime library included with Language Environment. For programs written in other languages, a language-neutral version of the POSIX functions is provided as a set of CMS callable services library (CSL) routines. These CSL routines are called by the C/C++ runtime routines to provide the functions, but they are also available to other applications. The CSL routines can be invoked as REXX functions through a REXX subcommand environment, ADDRESS OPENVM.

OpenExtensions includes a POSIX-compliant file system known as the Byte File System (BFS). BFS is a companion to the CMS Shared File System (SFS) that provides a byte-stream view of files. BFS allows data to be organized and used in a UNIX style and format.

Like SFS files, BFS files are organized in a hierarchical directory structure and stored in CMS file pools. While supporting the POSIX file system functions and rules, BFS also takes advantage of administration and system management facilities that it shares with SFS. These include space allocation, backup, and DFSMS/VM file migration, as well as other administrative functions.

CMS provides a set of OPENVM commands that allow users to manage their BFS directories and files and control their related permission and ownership attributes. CMS Pipelines additionally provides the ability to use BFS from pipeline programs.

The OpenExtensions shell and utilities provide a UNIX-like interactive environment in support of the POSIX application environment and provide tools that aid in program development and in porting applications from other open systems. Users of the shell environment have access to both the shell command set (built-in commands and utilities) and the full CP and CMS command sets, as well as both OpenExtensions and non-OpenExtensions applications. Each of the OpenExtensions POSIX.2 utilities additionally conforms to the X/Open Portability Guide, issue 4 (XPG4) for Commands and Utilities.

For an expanded introduction to OpenExtensions, see *z/VM: CMS Application Development Guide*.

For information about the program requirements for developing OpenExtensions applications, see “z/VM base components additional program requirements” on page 29.

Program Management Binder for CMS

The Program Management Binder for CMS (CMS Binder) is a CMS-enabled version of the z/OS MVS Program Management Binder. The CMS Binder converts the output of language translators and compilers into an executable program unit that can be either read directly into virtual storage for execution or stored in a program library. For more information, see *z/VM: Program Management Binder for CMS*.

Reusable Server Kernel

The Reusable Server Kernel enables vendors and application programmers to write multithreaded server programs that heavily exploit VM technologies. These servers can be constructed without knowledge of data transport mechanisms, multithreaded APIs, or I/O performance boosters and without reinventing API suites necessary in one server after another.

The Reusable Server Kernel is an "empty" server program that server writers can use as a starting point for developing and executing server programs on CMS. The Reusable Server Kernel consists of a text library of routines and a macro library of function prototypes and constant definitions. To construct an actual server program, the server author attaches application-specific code to a set of interfaces in the Reusable Server Kernel.

For more information, see *z/VM: Reusable Server Kernel Programmer's Guide and Reference*.

Virtual Machine Resource Manager

The Virtual Machine Resource Manager (VMRM) provides functions to:

- Manage guest performance

  A service virtual machine (SVM) accepts customer-defined workload definitions, goal specifications, and associations between them. The SVM then adjusts virtual machine CPU and I/O performance controls based on actual performance measurements to attempt to achieve the goals associated with each workload.
- Exploit I/O Priority Queueing

  A virtual equivalent of the hardware I/O Priority Queueing facility allows virtual machines running guest operating systems such as z/OS that exploit I/O Priority Queueing to determine the priority of their I/O operations within bounds that can be defined on z/VM. z/VM will automatically set a priority for I/O operations initiated by virtual machines that do not exploit this function.

VMRM Cooperative Memory Management (VMRM-CMM) between a z/VM system and Linux guests assists in managing memory constraint in the system. Based on several variables obtained from the system and storage domain CP monitor data, VMRM detects when there is such constraint, and notifies specific Linux virtual guests when this occurs. The guests can then take the appropriate action to adjust their memory utilization in order to relieve this constraint on the system, such as issuing a CP DIAGNOSE X'10' instruction to release pages of storage.

For more information about VMRM, see *z/VM: Performance*.

XEDIT

XEDIT is a full-screen editing facility that runs under CMS. XEDIT creates and modifies CMS files and BFS files. System macros and user-written procedures are performed from the XEDIT environment. For more information, see *z/VM: XEDIT User's Guide*.

HELP facility

The HELP facility runs under CMS and provides online assistance for various z/VM functions in the form of menus and panels. Help information is available for:

- Commands and subcommands
- Messages
- Tasks
- CMS Pipelines stages
- CMS callable routines
- REXX/VM, EXEC 2, and EXEC statements
- Assembler language macros
- Directory statements
- System configuration statements

Some facilities and features of z/VM, as well as other licensed programs that run on CMS, might provide help information for display through the HELP facility. You can also write your own help information. For more information, see *z/VM: CMS User's Guide*.

Dump Viewing Facility

The Dump Viewing Facility helps you interactively diagnose system problems. Using this facility, you can display, format, and print data interactively from virtual machine dumps, as well as display and format recorded trace data. The BLOCKDEF utility lets you display, format, and print control block information. The VIEWSYM command lets you display symptom records, making it easier to identify duplicate problems when they occur. For more information, see *z/VM: Dump Viewing Facility*.

Note: Analysis of CP stand-alone dumps, CP abend dumps, and virtual machine dumps of a CP system, functions formerly performed by the Dump Viewing Facility, are now performed by the VM Dump Tool. See "VM Dump Tool" on page 44.

Group Control System (GCS)

The Group Control System (GCS) runs in an XA or XC virtual machine in place of CMS. GCS is a virtual machine supervisor, providing multitasking services that allow numerous tasks to remain active in the virtual machine at one time. One of the functions of GCS is to support a native Systems Network Architecture (SNA) network. The SNA network relies on ACF/VTAM, VTAM SNA Console Support (VSCS), and other network applications to manage its collection of links between terminals, controllers, and processors. GCS provides services for ACF/VTAM, VSCS, and the others, which eliminates your need for VTAM Communications Network Application (VM/VCNA) and a second operating system like VSE. For more information, see *z/VM: Group Control System*.

Hardware Configuration Definition (HCD) and Hardware Configuration Manager (HCM) for z/VM

Hardware Configuration Definition (HCD) and Hardware Configuration Manager (HCM) provide a comprehensive I/O configuration management environment, similar to that available with the z/OS operating system.

HCM runs on a Windows based personal computer connected to the z/VM system through a TCP/IP network connection. HCM provides a graphical user interface as well as commands to help you configure your system. You supply the needed I/O configuration information to HCM, which processes the information and passes it to HCD.

HCD runs in a z/VM virtual machine and performs the work of actually creating and changing the hardware and software aspects of your I/O configuration. While HCM provides the primary user interface to HCD, HCD also provides a backup user interface on your z/VM host for certain I/O configuration tasks, in case HCM is not available.

The original dynamic I/O configuration capabilities of z/VM are still valid. These consist of a set of system operator commands for changing the hardware server's I/O configuration while the system continues to run, or for managing the hardware I/O configuration of all of the logical partitions in your server. You now have the choice of either using these commands or else using HCM and HCD to manage your I/O configuration. Note, however, that the use of HCM and HCD is incompatible with the original dynamic I/O configuration capabilities. You should select one method to use for the duration of any given IPL of your z/VM system.

For more information, see:

- "HCD and HCM additional program requirements" on page 30
- *z/VM: I/O Configuration*
- z/OS and z/VM: Hardware Configuration Manager User's Guide (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/eequ100_v3r1.pdf)

Language Environment

Language Environment provides the runtime environment for programs written in C/C++, COBOL, or PL/I. Language Environment helps you create mixed-language applications and gives you a consistent method of accessing common, frequently-used services.

Language Environment consists of:

- Basic routines that support starting and stopping programs, allocating storage, communicating with programs written in different languages, and indicating and handling conditions.
- Common library services, such as math services and date and time services, that are commonly needed by programs running on the system. These functions are supported through a library of callable services.
- Language-specific portions of the runtime library. Because many language-specific routines call Language Environment services, behavior is consistent across languages.

For more information, see:

- "Language Environment additional program requirements" on page 30
- *z/VM: Language Environment User's Guide*
- *z/OS: Language Environment Concepts Guide*.

REXX/VM

REXX/VM contains the REXX/VM Interpreter, which processes the English-like REXX programming language. It also contains the z/VM implementation of the SAA REXX programming language. REXX/VM provides a single source base for the REXX/VM Interpreter in the CMS and GCS components. The REXX/VM Interpreter exploits 31-bit addressing.

The REXX/VM Interpreter helps improve the productivity of your organization. Using REXX, you can write customized application programs and command procedures, tailor CMS commands, and create new XEDIT macros. For more information, see *z/VM: REXX/VM User's Guide*.

TCP/IP for z/VM

TCP/IP for z/VM brings the power and resources of your mainframe server to the Internet. TCP/IP for z/VM enables z/VM to participate in a multivendor, open networking environment using the TCP/IP protocol suite for communications and interoperability. The applications included in TCP/IP for z/VM provide the ability to transfer files, send mail, log on a remote host, allow access from any other TCP/IP node in the network, and perform other network client and server functions. Applications can be shared transparently across z/VM, z/OS, Linux, and other environments.

TCP/IP consists of a layered structure of protocols and functions. TCP/IP for z/VM provides the following types of functions:

Connectivity and gateway functions
Handle the physical interfaces and routing of data.

Server functions
Provide a service to a client (that is, send or transfer a file).

Client functions
Request a certain service from a server anywhere in the network.

Network status and management functions
Detect and solve network problems.

Application programming interfaces (APIs)
Allow you to write your own client/server applications.

Link protocols

Various network protocols compose the network layer available in TCP/IP. Network protocols define how data is transported over a physical network. These network protocols are not defined by TCP/IP. After a TCP/IP packet is created, the network protocol adds a transport-dependent network header before the packet is sent out on the network.

Network protocols

Protocols in the network layer provide connection services for TCP/IP. These protocols connect physical networks and transport protocols. The network protocols include Internet Protocol (IP), Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), and Internet Group Management Protocol.

Internet protocol

The Internet Protocol (IP) provides the interface from the transport layer (host-to-host, TCP, or UDP) protocols to the physical-level protocols. IP is the basic transport mechanism for routing IP packets to the next gateway, router, or destination host.

In TCP/IP for z/VM, a single stack provides support for static routing of IP version 6 (IPv6) traffic and IPv4 traffic. IPv6 uses 128-bit addresses. However, the z/VM TCP/IP stack cannot be configured as a tunnel endpoint for tunneling IPv6 traffic over IPv4 networks.

Transport protocols

The transport layer of TCP/IP consists of transport protocols, which allow communication between application programs.

Transmission Control Protocol

The Transmission Control Protocol (TCP) provides a reliable vehicle for delivering packets between hosts on an internet. TCP takes a stream of data, breaks it into datagrams, sends each one individually using Internet Protocol (IP), and reassembles the datagrams at the destination node. If any datagrams are lost or damaged during transmission, TCP detects this and re-sends the missing datagrams. The received data stream is a reliable copy of the transmitted data stream.

User Datagram Protocol

The User Datagram Protocol (UDP) provides an unreliable mode of communication between source and destination hosts. UDP is a datagram-level protocol built directly on the IP layer. UDP is used for application-to-application programs between TCP/IP hosts.

Like IP, UDP does not offer a guarantee of datagram delivery or duplication protection. UDP does provide checksums for both the header and data portions of a datagram. However, applications that require reliable delivery of streams of data should use TCP.

Applications and protocols

TCP/IP applications allow users to use network services. These applications are included in the application layer of TCP/IP. The application layer is built on the services of the transport layer. TCP/IP for z/VM supports the following applications and protocols:

- **Domain Name System (DNS)** is a hierarchical naming system for naming hosts.

  Note: The native z/VM DNS server is no longer supported, but z/VM still supports the DNS protocol using non-z/VM servers.
- **File Transfer Protocol (FTP)** allows you to transfer data between local and foreign hosts or between two foreign hosts.
- **Lightweight Directory Access Protocol (LDAP)** provides user authentication, authorization, and auditing capabilities.

- **MPRoute** uses either Open Shortest Path First (OSPF) or Routing Information Protocol (RIP), or both, to dynamically create and maintain network routing tables.
- **Network File System (NFS)** allows you to manipulate files on different TCP/IP hosts as if they reside on your host.
- **Remote Execution Protocol (REXEC)** allows you to execute a command on a foreign host and receive the results on the local host.
- **Remote Printing (LPR and LPD)** provides both client and server support for remote printing.

  Note: LPD protocol is supported within RSCS.
- **Remote Procedure Call (RPC)** is a programming interface that calls subroutines to be executed on a foreign host.
- **Simple Mail Transfer Protocol (SMTP)** is an electronic mail protocol that is implemented with the CMS NOTE and SENDFILE commands.
- **Simple Network Management Protocol (SNMP)** provides a means for managing an internet environment.
- **Secure Sockets Layer (SSL)** is a cryptographic protocol that provides communication security over the Internet.
- **Socket interfaces** allow you to write your own applications to supplement those supplied by TCP/IP.
- **Telnet Protocol** provides a standard method to interface terminal devices and terminal-oriented processes with each other.
- **Transport Layer Security (TLS)** is a cryptographic protocol that provides communication security over the Internet.
- **Trivial File Transfer Protocol** reads and writes files to and from a foreign host.

TCP/IP requirements and additional information

For additional information about TCP/IP for z/VM, see:

- “TCP/IP hardware requirements” on page 26
- “TCP/IP additional program requirements” on page 32
- “TCP/IP security” on page 38
- *z/VM: TCP/IP Planning and Customization*
- *z/VM: TCP/IP User's Guide*

Transparent Services Access Facility (TSAF)

The Transparent Services Access Facility (TSAF) provides communication services within a collection of z/VM systems without using VTAM. TSAF runs in a CMS virtual machine. A group of up to eight z/VM systems that each have TSAF installed and running can form a TSAF collection. APPC/VM programs on one z/VM system in the TSAF collection can communicate with other APPC/VM programs on the other z/VM systems in the collection. The routing is transparent to the application programs. Communications between the applications proceed as if the applications were running on the same system. For more information, see *z/VM: Connectivity*.

Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E)

Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E) helps you install z/VM and other VMSES/E-enabled products and apply code changes that correct or circumvent reported problems. VMSES/E handles both source code and object code.

VMSES/E can also help you define, build, and manage saved segments. The VMFSGMAP command provides a saved segment mapping interface that lets you modify saved segment definitions and view saved segment layouts prior to actually building them on your system.

For more information, see *z/VM: VMSES/E Introduction and Reference*.

Chapter 5. z/VM optional features

z/VM offers the following optional features:

Data Facility Storage Management Subsystem for z/VM (DFSMS/VM)

Data Facility Storage Management Subsystem for z/VM (DFSMS/VM) allows you to control your data and storage resources more efficiently. DFSMS/VM provides:

- Space Management

  DFSMS/VM improves DASD utilization by automatically managing space in SFS file pools. As the SFS administrator, DFSMS/VM allows you to:

  - Convert SFS storage to DFSMS/VM-managed storage by assigning *management classes* to files and directories. Each management class tells DFSMS/VM how to treat its members in the course of its management of the file pool.
  - Automatically manage files based on the criteria in each management class. This management may consist of deletion of files, automatic migration of files, or both.
  - *Migrate* (or move) files from DFSMS/VM-managed storage to DFSMS/VM-owned storage by using the assigned *management class*. This function also compresses the data. The files can be automatically recalled when referenced (opened and browsed), or they can be explicitly recalled.
- Minidisk Management

  Using DFSMS/VM for minidisk management allows you to check the integrity of CMS minidisks and move them from one location to another. DFSMS/VM helps you migrate CMS minidisks to new DASD quickly, efficiently, and with minimal impact to users.
- Interactive Storage Management Facility (ISMF)

  DFSMS/VM uses the ISMF to provide a consistent user interface for storage management tasks.
- IBM Tape Library Dataserver Support

  DFSMS/VM Removable Media Services (RMS) provides native z/VM support for IBM Tape Library Dataservers. For a list of the supported devices, see "Tape units and tape libraries" on page 100.

For more information, see:

- "DFSMS/VM additional program requirements" on page 29
- "DFSMS/VM publications" on page 80

Directory Maintenance Facility for z/VM (DirMaint)

Directory Maintenance Facility for z/VM (DirMaint) provides efficient and secure interactive facilities for maintaining your z/VM system directory. Directory management is simplified by DirMaint's command interface and automated facilities. DirMaint provides a corresponding command for every z/VM directory statement. DirMaint's error checking ensures that only valid changes are made to the directory, and that only authorized personnel are able to make the requested changes.

Program highlights include:

- DirMaint operates as a CMS application and uses CMS interfaces for CMS and CP services. As a CMS application, DirMaint is not dependent on specific hardware, although it does verify that the device types specified in DirMaint commands are only those supported by the z/VM host.
- DirMaint functions are accomplished by two disconnected virtual machines equipped with an automatic restart facility. The use of virtual machines takes advantage of the inherent reliability, availability, and serviceability of the system architecture.
- Any transaction requiring the allocation or deallocation of minidisk extents can be handled automatically.
- All user-initiated transactions can be password-controlled and can be recorded for auditing purposes.
- Command authorization is controlled by assigning DirMaint commands to privileged command sets. Users may be authorized to issue commands from multiple command sets. DirMaint provides nine predefined command sets, but up to 36 sets are supported.
- User exit routines enable centralized directory maintenance of remote systems. Some exit routines also enable DirMaint to interact with other facilities, such as RACF.
- The open command structure allows you to replace any and all commands with your own user-written commands.
- An automated process for copying CMS minidisk files minimizes the possibility of human error. This process optionally formats the old (source) minidisk before returning it to the available minidisk pool.
- The integrity of CMS files is ensured by preventing new minidisk space from being inadvertently allocated over existing extents.
- DirMaint improves overall system efficiency by minimizing the number of DIRECTXA utility runs required. The update-in-place facility (DIAGNOSE code X'84') can be used to place many of the changes online immediately.
- System security is enhanced by providing the ability to enforce regular password changes. When changing the password, the user is required to enter the new password twice to guard against typographical errors.
- An additional level of security can be implemented by using the `needpass` option to require that a password be entered for every user transaction. This is not the default.

For more information, see:

- “DirMaint system integrity” on page 36
- “DirMaint security” on page 38
- “DirMaint additional program requirements” on page 30
- “Directory Maintenance Facility for z/VM publications” on page 81

Performance Toolkit for z/VM

Performance Toolkit for z/VM assists operators and systems programmers or analysts in the following areas:

- Operation of the system operator console in full screen mode
- Support for managing multiple VM systems
- Post processing of VM history files
- Performance monitoring
- Serving data through a web server for viewing with web browsers
- PC-based graphics
- TCP/IP performance reporting

In addition to analyzing VM performance data, Performance Toolkit can process performance data collected by Linux guests.

For more information, see:

- “Performance Toolkit hardware requirements” on page 25
- “Performance Toolkit additional program requirements” on page 31
- “Performance Toolkit for z/VM publications” on page 82

z/VM Performance Data Pump

z/VM Performance Data Pump (Data Pump) converts machine-readable z/VM monitor and SFS data into a generic text-based data stream. Modern tools can use the data stream to display real-time performance dashboards, aggregate real-time data for long-term usage analysis, or integrate with existing enterprise observability solutions.

Data Pump provides high-quality z/VM performance data to enterprise monitoring tools that are already deployed for application monitoring or capacity planning. Such tools align with skills and experiences of many users and offer integration with other tools and solutions.

Data Pump by itself does not deliver value that a user can readily use. To take advantage of Data Pump the customer must provision, configure, and deploy other services to process the data stream. While instructions for deploying the open source solutions are available, these components are not delivered with the z/VM product. For more information, see z/VM Performance Data Pump (https://www.vm.ibm.com/related/perfkit/datapump/).

z/VM Performance Data Pump is licensed with Performance Toolkit for z/VM but does not support, depend upon, or interact with Performance Toolkit for z/VM in any way.

For more information, see the following topics:

- “z/VM Performance Data Pump additional program requirements” on page 31
- “Performance Toolkit for z/VM publications” on page 82
- z/VM Performance Data Pump in *z/VM: Performance*

RACF Security Server for z/VM

RACF Security Server for z/VM is a security tool that works together with existing functions in the z/VM base system to provide improved data security for an installation. RACF protects information by controlling access to it. RACF also controls what you can do on the operating system and protects your resources. It provides this security by identifying and verifying users, authorizing users to access protected resources, and recording and reporting access attempts.

To help each installation meet its unique security needs and objectives, RACF provides:

- Protection of installation-defined resources
- Flexible control of access to protected resources
- The ability to store information for other products
- A choice of centralized or decentralized control profiles
- Transparency to end users
- Exits for installation-written routines

Your organization can define individuals and groups who use the system that RACF protects. A security administrator uses RACF to define a profile for each individual that identifies that person's user ID, password, and other information. A group is a collection of individuals who have common needs and requirements. For example, a whole department may be defined as one group. Your organization can also define what authorities you have, or what authorities a group you belong to has. RACF controls what you can do on the system. Some individuals have a great degree of authority, while others have little authority. The degree of authority you are given is based on what you need to do your job.

In addition to defining user and group authorities, RACF protects resources. You can protect system resources and user resources. System resources include system minidisks, system SFS files and

directories, certain VM events, and terminals. User resources include user minidisks and user SFS files and directories.

RACF stores all this information about users, groups, and resources in profiles. A profile is a record of RACF information that has been defined by the security administrator. There are user, group, and resource profiles. Using the information in its profiles, RACF authorizes access to certain resources. RACF applies user attributes, group authorities, and resource authorities to control use of the system. The security administrator or someone in authority in your organization controls the information in your user profile, in group profiles, and in resource profiles. You, as an end user, control the information in profiles describing your own resources, such as your own minidisks. You can protect your data by setting up resource profiles. You can set up an access list in your resource profile to control who has read-access and who has write-access to your data.

In addition to uniquely identifying and authorizing users, RACF can record what users do on the system. It keeps track of what happens on the system so that an organization can monitor who is logged on to the system at any given time. RACF reports if persons have attempted to perform unauthorized actions. For example, RACF can record when someone who does not have the proper authority tries to use or change your data. The security administrator can monitor these activities and generate reports.

For more information, see:

- "RACF additional program requirements" on page 31
- "RACF Security Server for z/VM publications" on page 82

RSCS Networking for z/VM

Remote Spooling Communications Subsystem (RSCS) Networking for z/VM is a networking program that enables users on a z/VM system to send messages, files, commands, and jobs to other users within a network. RSCS connects nodes (systems, devices, and workstations) using links. These links allow data, consisting mainly of CP spool files, to be transferred between the nodes.

Running under the GCS component of z/VM, RSCS uses the spooling facilities of z/VM to store and retrieve data. z/VM handles data transfer within its system by means of spooling. RSCS extends the basic spooling capabilities of z/VM, handling data transfer between the z/VM system and outside sources. Data is stored on a spool after RSCS receives it and until RSCS can forward it to its destination. RSCS uses communications equipment to transfer data between the local z/VM system and other systems or remote locations.

A node in an RSCS network is either a system node or a station node. A station node can originate and receive information. It can be a computer, a workstation, or a printer. A system node, however, must be a computer. Besides originating and receiving information, system nodes can also relay information between two other nodes.

RSCS can communicate with system nodes that are running under the control of network job entry (NJE) compatible subsystems, such as:

- JES2 or JES3
- RSCS
- VSE/POWER®
- AS/400 Communications Utilities
- Products that provide NJE functions for Linux or AIX®

For more information about NJE, see z/OS: Network Job Entry (NJE) Formats and Protocols (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/hasa600_v3r1.pdf).

RSCS can communicate with station nodes that are:

- ASCII printers or plotters
- Computers running under the control of a system that can provide a multileaving protocol
- IBM 3270 Information Display System Printers

- Line printer router (LPR) daemons and clients in a TCP/IP network
- Unsolicited File Transfer (UFT) daemons and clients in a TCP/IP network
- Workstations running under the control of remote job entry (RJE)

Each link in an RSCS network is associated with a programming routine, called a driver, that manages the transmission and reception of files, messages, and commands over the link. The way that a driver manages the data is called a protocol. All file transmission between networking nodes uses NJE protocol, 3270 printers use 3270 data streams, workstations use RJE protocol, and ASCII printers use data streams appropriate to that printer. Systems Network Architecture (SNA) provides one set of protocols that governs communications on links. The method that RSCS uses for sending data to a node varies, depending on the type of connection used to establish the link. RSCS can support non-SNA (such as binary synchronous communication or channel-to-channel), SNA, and TCP/IP connections.

TCPNJE-type links can communicate securely when configured with an x.509 digital certificate that will be used to encrypt/decrypt all data flowing over the link using TLS protocols.

For more information, see:

- “RSCS additional program requirements” on page 31
- “RSCS Networking for z/VM publications” on page 83

Chapter 6. z/VM library guide

This guide includes the following topics:

Where to get information about z/VM

Information about z/VM is available from several sources.

Documentation supplied with z/VM

The following documentation is supplied with z/VM:

- One copy of the *z/VM Agreements and License Information*
- z/VM help files (included in the z/VM system image).

z/VM 7.4 Library

Current and previous editions of z/VM publications can be obtained from these sources:

HTML and PDF formats

IBM Documentation - z/VM (https://www.ibm.com/docs/en/zvm). This is the official home of the documentation for z/VM and other IBM products, replacing IBM Knowledge Center. (IBM Knowledge Center URLs are redirected to the corresponding IBM Doc URLs permanently.)

To learn more about IBM Docs, go to the IBM Docs welcome page (https://www.ibm.com/docs) and do the following:

- To take a quick look at some of the features of IBM Docs, click on the black **Guided tour** button to the right of the **Search in IBM Documentation** field.
- To search for a product, click on the black **View all products in IBM Documentation** button. This takes you to the IBM Documentation products page.

  Type the product name in the **Filter within the product catalog** field (or click on the first letter of the product name in the menu below that) and then click on the product name shown in the search results.

PDF format only

PDF collections: IBM: z/VM Library Indexed PDF collections (https://www.vm.ibm.com/library/pdfzip.html). For more information, see "z/VM Adobe Indexed PDF Collection" on page 69.

Individual PDFs: IBM: z/VM Internet Library (https://www.ibm.com/vm/library). For more information, see "z/VM Internet Library" on page 70.

z/VM Adobe Indexed PDF Collection

The *z/VM Adobe Indexed PDF Collection* is designed to provide users with an offline way to search the z/VM library. The collection contains PDF files for all the publications in the z/VM library, an HTML index listing the titles, and an Adobe Acrobat full text search index for the entire collection. Using the search index, you can perform a comprehensive search across all the PDFs delivered in the collection. To read and search the PDF files, all you need is the Adobe Acrobat Reader. Search results are displayed in context by publication title to help users who are familiar with the library to find the information they want more quickly.

The collection is refreshed regularly as part of the z/VM Continuous Delivery model.

Collections are available as zip files that you can download from IBM Documentation - z/VM (https://www.ibm.com/docs/en/zvm) and IBM: z/VM Library Indexed PDF collections (https://www.vm.ibm.com/library/pdfzip.html).

z/VM Internet Library

IBM: z/VM Internet Library (https://www.ibm.com/vm/library) is the Library page of the z/VM website, which provides links to various z/VM information resources, including:

- Archived editions of z/VM publications
- z/VM Adobe Indexed PDF Collections
- z/VM program directories
- z/VM data areas, control blocks, and monitor records
- IBM Redbooks® publications
- White papers, consultant reports, and performance reports
- Data sheets and brochures
- Reference guides
- Journals, bulletins, and newsletters

z/VM Education How-to Guides

Short videos that provide guides about different z/VM-related tasks are part of the IBM Support and Training YouTube channel. You can find, like, and subscribe to a playlist of these videos at z/VM Education How-to Guides (https://ibm.biz/zvmhowto-yt).

List Server Discussion Groups

List Server Discussion Groups (https://www.vm.ibm.com/techinfo/listserv.html) are hosted by educational institutions and customer sites. Participants are IBM customers, ISVs, those interested in the subject discussion, and IBMers.

Abstracts of the z/VM base product publications

The z/VM base product publications include z/VM publications and other IBM publications that provide related information. The base product publications are grouped into the following task-related categories:

System overview

These publications provide information about z/VM capabilities and requirements, terminology, and specific license terms.

z/VM: General Information, GC24-6286

z/VM: General Information provides the following information about z/VM:

- Product overview
- What is new or changed in the latest z/VM release

- Hardware and software requirements
- Guide to the product documentation
- IBM servers, guest operating systems, and devices supported by current z/VM releases

z/VM: License Information, GI13-4377
z/VM: License Information is a supplement to the IBM International Program License Agreement, and includes terms specific to z/VM.

Installation, migration, and service

These publications provide information to help you install and maintain a z/VM system.

z/VM: Installation Guide, GC24-6292
z/VM: Installation Guide contains step-by-step procedures for installing a z/VM system. The procedures feature an automated installation process using a panel interface to load a prebuilt z/VM system image packaged as an electronic image in ISO format. Installation worksheets are included that you can use to plan your installation.

z/VM: Migration Guide, GC24-6294
z/VM: Migration Guide provides a history of the new functions, enhancements, and other support that have been added to z/VM since 5.4, either in new releases or via between-release enhancements provided in the service stream. Two types of information are provided:

- Descriptions of the new z/VM functions, enhancements, and support.
- Identification of the z/VM external interfaces that have changed, including an assessment of the compatibility of each change – upwardly compatible or incompatible.

z/VM: Service Guide, GC24-6325
z/VM: Service Guide contains step-by-step procedures for installing preventive and corrective service to the z/VM components and the preinstalled z/VM facilities and features. This document should be used in conjunction with *z/VM: VMSES/E Introduction and Reference*.

z/VM: VMSES/E Introduction and Reference, GC24-6336
z/VM: VMSES/E Introduction and Reference provides an overview of the Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E) component of z/VM. It describes how to use VMSES/E tools to install, migrate, build, service, and delete licensed program from a more general, less z/VM-specific point of view than *z/VM: Installation Guide* and *z/VM: Service Guide*. This document discusses the software inventory and how you can use it to manage the licensed programs on your system. Reference information is provided about the product parameter file, software inventory tables, VMSES/E commands, and other related commands.

Planning and administration

These publications provide information to help you define and manage a z/VM system. Planning is an iterative task in that many of the decisions are made before installation, are continually evaluated after installation, and are revised as appropriate. The administration task involves defining the characteristics of data processing resources to z/VM. The resources can be data files, databases, programs, users, and so forth.

z/VM: CMS File Pool Planning, Administration, and Operation, SC24-6261
z/VM: CMS File Pool Planning, Administration, and Operation provides information on planning for, administering, and operating CMS file pools. It provides information about using file pools as repositories for CMS Shared File System (SFS) and OpenExtensions Byte File System (BFS) data. It also provides information about using file pool server machines for Coordinated Resource Recovery (CRR) and FIFO functions. The document includes a reference section that contains descriptions of file pool startup parameters and file pool administration and server commands.

z/VM: CMS Planning and Administration, SC24-6264
z/VM: CMS Planning and Administration provides information on the Conversational Monitor System (CMS) component of z/VM, including:

- Tailoring CMS

- Administering CMS Pipelines
- Planning for VSE simulation and VSAM support
- Setting up and using the Programmable Operator Facility
- Managing the CMS batch facility

z/VM: Connectivity, SC24-6267
z/VM: Connectivity provides an overview of the z/VM facilities that enable logical connections between systems. This document presents basic connectivity concepts and planning considerations. It describes how to plan and set up real networks (using OSA-Express and HiperSockets) and virtual networks (using guest LANs and virtual switches). It also provides information about using server and requester virtual machines, the Transparent Services Access Facility (TSAF), APPC/VM VTAM Support (AVS), and the Inter-System Facility for Communications (ISFC).

z/VM: CP Planning and Administration, SC24-6271
z/VM: CP Planning and Administration provides information about the Control Program (CP) component of z/VM:

- System planning and administration

  This section includes information on creating and updating the system configuration file, setting up service virtual machines, using the stand-alone dump utility, using z/VM HiperDispatch, and other topics.
- User planning and administration

  This section includes information on creating and updating a user directory and redefining command privilege classes.
- Storage planning and administration

  This section includes information on managing real storage, allocating DASD space, sharing DASD, defining and managing SCSI FCP disks, and other topics.
- Single system image clusters planning and administration

  This section includes information on setting up a z/VM single system image (SSI) cluster, preparing for guest relocations in an SSI cluster, and other topics.

z/VM: Getting Started with Linux on IBM Z, SC24-6287
z/VM: Getting Started with Linux on IBM Z describes how to configure and use z/VM functions and facilities for Linux servers running on the IBM Z platform. This document is designed to help system administrators who have limited knowledge of z/VM, but want to deploy Linux servers on z/VM. The document provides requirements and guidelines to implement during z/VM installation, but primarily assumes that z/VM is installed and you are ready to deploy Linux servers in z/VM virtual machines. Topics covered include:

- z/VM basics
- Planning for Linux virtual servers
- Changing the z/VM system configuration
- Configuring the Directory Maintenance Facility
- Configuring TCP/IP for z/VM
- Creating and cloning Linux virtual machines
- Setting up basic system automation
- Performing runtime tasks
- Monitoring performance and capacity
- Servicing z/VM
- Preparing for live guest relocation
- Using FTP to install Linux from the hardware management console

z/VM: Group Control System, SC24-6289
z/VM: Group Control System provides information about the Group Control System (GCS) component of z/VM. GCS is a virtual machine supervisor. It bands many virtual machines together in a group and supervises their operations. The specific function of GCS is to support a native VM Systems Network Architecture (SNA) network. This document is intended for anyone writing programs that run under GCS. It provides planning information and describes the purpose and use of GCS commands and macroinstructions.

z/VM: I/O Configuration, SC24-6291
z/VM: I/O Configuration describes how to plan the I/O configuration (channel paths, control units, and I/O devices) on your z/VM system. Two methods are described. Part 1 describes how to use Hardware Configuration Definition (HCD) and Hardware Configuration Manager (HCM) to manage the hardware and software I/O configuration. HCM is a Windows based program that provides a graphical user interface. Part 2 describes how to use z/VM dynamic I/O configuration, which is a command interface for modifying the hardware I/O configuration.

z/VM: Running Guest Operating Systems, SC24-6321
z/VM: Running Guest Operating Systems contains information to help you plan for and run guest operating systems under the supervision of z/VM. It discusses the fundamentals of guest support in z/VM and provides specific information on how to run z/OS, VSE, or z/VM in a virtual machine.

For information about running Linux in a virtual machine, see z/VM: Getting Started with Linux on IBM Z.

z/VM: Saved Segments Planning and Administration, SC24-6322
z/VM: Saved Segments Planning and Administration provides information about using saved segments on your z/VM system. It includes information on the following topics:

- Planning and defining CP saved segments
- Planning and defining CMS logical saved segments
- Using VMSES/E to define, build, and manage saved segments

z/VM: Secure Configuration Guide, SC24-6323
z/VM: Secure Configuration Guide describes the steps necessary to configure your z/VM installation to conform with the requirements of the Common Criteria.

z/VM: TCP/IP LDAP Administration Guide, SC24-6329
z/VM: TCP/IP LDAP Administration Guide contains information to assist administrators in using the z/VM TCP/IP Lightweight Directory Access Protocol (LDAP) server to maintain directory information. The LDAP server provides user authentication, authorization, and auditing capabilities.

z/VM: TCP/IP Planning and Customization, SC24-6331
z/VM: TCP/IP Planning and Customization provides information to help you plan and set up TCP/IP networks on your z/VM system. It describes how to define and configure the virtual machines, servers, and applications available in TCP/IP for z/VM. It also describes how to customize and tune TCP/IP for your specific needs.

z/OS and z/VM: Hardware Configuration Manager User's Guide, SC34-2670
z/OS and z/VM: Hardware Configuration Manager User's Guide (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/eequ100_v3r1.pdf) describes how to use the Hardware Configuration Manager (HCM) graphical user interface to create and maintain hardware configuration information.

Open Systems Adapter-Express Customer's Guide and Reference, SA22-7935
Open Systems Adapter-Express Customer's Guide and Reference (https://www.ibm.com/docs/en/SSLTBW_2.3.0/pdf/ioa2z1f0.pdf) provides step-by-step instructions for setting up and using the Open Systems Adapter Facility (OSA/SF) to configure and manage OSA-Express server features.

Open Systems Adapter-Express Integrated Console Controller User's Guide, SC27-9003
Open Systems Adapter Integrated Console Controller User's Guide (https://www.ibm.com/docs/en/SSLTBW_2.3.0/pdf/SC27-9003-02.pdf) provides instructions for setting up and using the Open Systems Adapter-Express Integrated Console Controller (OSA-ICC), a function of the OSA-Express 1000BASE-T Ethernet adapter that integrates 3270 emulation for console session connections into IBM Z servers.

Open Systems Adapter/Support Facility on the Hardware Management Console, SC14-7580
Open Systems Adapter/Support Facility on the Hardware Management Console (https://www.ibm.com/docs/en/SSLTBW_2.3.0/pdf/SC14-7580-02.pdf) describes how to use the Open Systems Adapter/Support Facility on the Hardware Management Console.

Customization and tuning

These publications provide information about extending or enhancing a z/VM system.

z/VM: CP Exit Customization, SC24-6269
z/VM: CP Exit Customization describes how to customize a z/VM system using CP exit points, both IBM-defined and customer-written. Topics include:

- Creating and controlling dynamically loaded routines
- Defining CP commands and DIAGNOSE codes
- Defining and using CP exit points
- Creating and using CP message repositories

z/VM: Performance, SC24-6301
z/VM: Performance contains information about the planning, managing, measuring, and tuning considerations needed to obtain optimum z/VM system performance. It provides an overview of z/VM system characteristics and discusses performance methodology, planning measures, monitoring facility tools, and tuning actions.

Operation and use

These publications provide information about operating a z/VM system and using z/VM commands and other functions.

z/VM: CMS Commands and Utilities Reference, SC24-6260
z/VM: CMS Commands and Utilities Reference provides detailed reference information on all general-use CMS commands, z/VM HELP Facility format words, and CMS utilities (functions intended primarily for system programmers).

z/VM: CMS Primer, SC24-6265
z/VM: CMS Primer introduces the Conversational Monitor System (CMS) component of z/VM and provides information on basic CMS tasks. It presents, through examples, a portion of the functions and commands available with CMS, with the primary emphasis on:

- Logging on
- Editing and working with files
- Using the Shared File System (SFS)
- Communicating with other users

z/VM: CMS User's Guide, SC24-6266
z/VM: CMS User's Guide describes how to use various facilities provided by CMS. Topics include:

- Managing your file system
- Creating and maintaining an online Help facility
- Using windowing commands and full-screen CMS
- Modifying and running execs and programs

This document is intended for users with a general understanding of CMS, who want to use CMS at a more advanced level. Users with no CMS knowledge should first read *z/VM: CMS Primer*.

z/VM: CP Commands and Utilities Reference, SC24-6268
z/VM: CP Commands and Utilities Reference provides detailed reference information on Control Program (CP) commands and system utilities for users of every privilege class. System utilities perform CP functions but operate only in the CMS environment.

z/VM: System Operation, SC24-6326
z/VM: System Operation explains how to operate a z/VM system. It provides information about system operator tasks, such as:

- Using the Stand-Alone Program Loader (SAPL)
- Bringing up, running, and shutting down the system
- Controlling local devices
- Responding to errors
- Collecting information about system operation
- Performing data management services
- Running utility programs

z/VM: TCP/IP User's Guide, SC24-6333
z/VM: TCP/IP User's Guide is intended for end users and describes how to use TCP/IP after it has been installed and customized on a network. The document explains how to use the applications available in TCP/IP, including:

- Transferring files
- Sending electronic mail
- Logging on to a foreign host
- Using LDAP operation utilities
- Monitoring the TCP/IP network
- Using Network File System commands
- Using remote printing
- Managing TCP/IP network resources with SNMP
- Using the Domain Name System

z/VM: Virtual Machine Operation, SC24-6334
z/VM: Virtual Machine Operation contains information about operating a z/VM virtual machine. It might be particularly useful for the user who wants to set up a virtual machine in which to run a guest operating system. The document includes topics such as:

- Setting up, starting, and operating a virtual machine
- Communicating with the guest operating system and with the z/VM Control Program
- Managing the storage, processor, and I/O resources of a virtual machine
- Using z/VM facilities to test programs running in a virtual machine

z/VM: XEDIT Commands and Macros Reference, SC24-6337
z/VM: XEDIT Commands and Macros Reference provides detailed reference information on the XEDIT command, subcommands, and macros. Users should first read *z/VM: XEDIT User's Guide*.

z/VM: XEDIT User's Guide, SC24-6338
z/VM: XEDIT User's Guide provides a working knowledge of the z/VM system editor, XEDIT. XEDIT provides a wide range of functions for text processing and programming development. Because it is both a full-screen and a line-mode editor, XEDIT can be used on display and on typewriter terminals.

Application programming

These publications provide information about creating application programs to do specific functions on z/VM. The publications describe the primary application programming interfaces (APIs) provided by z/VM.

Architecture principles of operation books:

z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation, SC24-6285
z/VM: ESA/XC Principles of Operation provides a detailed description of the Enterprise System Architecture/Extended Configuration (ESA/XC) virtual machine architecture. It describes how

ESA/XC operates as compared to Enterprise Systems Architecture/390 (ESA/390), upon which ESA/XC is based. It is intended as a reference for programmers who write or debug programs that run in ESA/XC virtual machines.

z/VM: z/Architecture Extended Configuration (z/XC) Principles of Operation, SC27-4940
z/VM: z/Architecture Extended Configuration (z/XC) Principles of Operation provides a detailed description of the z/Architecture Extended Configuration (z/XC) virtual machine architecture. It describes how z/XC operates. It compares z/XC to z/Architecture, from which z/XC is derived, and to ESA/XC. It is intended as a reference for programmers who write or debug programs that run in z/XC virtual machines.

z/VM: CMS Application Development Guide, SC24-6256
z/VM: CMS Application Development Guide provides information about developing application programs in CMS. The development process includes planning, designing, writing, compiling, debugging, executing, and updating. This document also describes the following CMS services and how you can use them to develop an application:

- Shared File System (SFS)
- OpenExtensions
- Common Programming Interface (CPI) Communications
- Coordinated Resource Recovery (CRR)
- VM Data Space support
- CMS libraries
- CMS Batch Facility
- Parsing facility
- Message repositories

z/VM: CMS Application Development Guide for Assembler, SC24-6257
z/VM: CMS Application Development Guide for Assembler provides information to help assembler language programmers:

- Understand CMS programming interfaces and virtual machine architecture
- Use CMS services to build, load, run, and package assembler programs
- Develop OS/MVS and VSE applications under CMS
- Use Access Methods Services and VSAM under CMS and CMS/DOS

z/VM: CMS Application Multitasking, SC24-6258
z/VM: CMS Application Multitasking describes how you can use CMS multitasking to develop and run multitasking application programs written in C/C++, assembler, or REXX. The document provides introductory and tutorial information as well as detailed reference material.

z/VM: CMS Callable Services Reference, SC24-6259
z/VM: CMS Callable Services Reference describes the basic set of CMS callable services library (CSL) routines. These CSL routines primarily perform functions related to CMS file system management and CMS file pool administration.

z/VM: CMS Macros and Functions Reference, SC24-6262
z/VM: CMS Macros and Functions Reference describes the preferred CMS macroinstructions and functions. It also describes the CMS macros and functions supported only for compatibility (because they support only 24-bit addressing).

z/VM: CMS Pipelines User's Guide and Reference, SC24-6252
z/VM: CMS Pipelines User's Guide and Reference describes the general concepts of CMS Pipelines and how to use CMS Pipelines, and provides reference information on the CMS Pipelines stages, subcommands, and assembler macros.

z/VM: CP Programming Services, SC24-6272
z/VM: CP Programming Services including:

- DIAGNOSE instructions

- Inter-User-Communications Vehicle (IUCV)
- Advanced Program-to-Program Communications for VM (APPC/VM)
- CP System Services
- ESA/XC and z/XC address-space management macros
- Symptom record reporting
- Access Control Interface (ACI) for an external security manager

z/VM: CPI Communications User's Guide, SC24-6273
z/VM: CPI Communications User's Guide provides step-by-step instructions for using Systems Application Architecture® (SAA) Common Programming Interface (CPI) Communications to write communications programs to run in the CMS environment. Sample programs written in REXX/VM show how to use SAA CPI Communications calls and the CMS extensions to CPI Communications.

z/VM: Language Environment User's Guide, SC24-6293
z/VM: Language Environment User's Guide provides information for using Language Environment for z/VM, which is based on z/OS Language Environment. It provides information unique to the z/VM platform and is intended to be used in conjunction with the z/OS Language Environment documentation (included in the z/VM library). See:

- z/OS: Language Environment Concepts Guide
- z/OS: Language Environment Programming Guide
- z/OS: Language Environment Programming Reference

z/VM: OpenExtensions Advanced Application Programming Tools, SC24-6295
z/VM: OpenExtensions Advanced Application Programming Tools provides advanced information for using the OpenExtensions utilities `lex`, `yacc`, and `make`.

z/VM: OpenExtensions Callable Services Reference, SC24-6296
z/VM: OpenExtensions Callable Services Reference describes the callable services that provide interfaces between z/VM and the functions specified in the IEEE POSIX.1 standard. These services are used by the POSIX calls in the C/C++ runtime library. This document also describes callable services that are not related to the standards.

z/VM: OpenExtensions Commands Reference, SC24-6297
z/VM: OpenExtensions Commands Reference describes the OpenExtensions commands and utilities. It also describes the CMS OPENVM commands, which are used to obtain OpenExtensions services.

z/VM: OpenExtensions POSIX Conformance Document, GC24-6298
z/VM: OpenExtensions POSIX Conformance Document describes the z/VM implementation of those areas of the Institute of Electrical and Electronics Engineers (IEEE) Portable Operating System Interface for Computer Environments (POSIX) standards that were declared to be optional or implementation-defined. This document describes the z/VM implementation for both POSIX.1 and POSIX.2. The implementation of these standards in z/VM is known as OpenExtensions and is included in CMS.

z/VM: OpenExtensions User's Guide, SC24-6299
z/VM: OpenExtensions User's Guide describes the OpenExtensions Byte File System (BFS) and provides information for using the OpenExtensions shell commands. The shell provides a UNIX-like interactive user environment.

z/VM: Program Management Binder for CMS, SC24-6304
z/VM: Program Management Binder for CMS describes how to use the Program Management binder for CMS (CMS binder). The CMS binder is based on the z/OS MVS Program Management Binder, and this document describes the differences in usage and behavior between the two programs. This document is intended to be used in conjunction with the z/OS MVS Program Management documentation (included in the z/VM library). See:

- z/OS MVS Program Management: User's Guide and Reference
- z/OS MVS Program Management: Advanced Facilities

z/VM: Reusable Server Kernel Programmer's Guide and Reference, SC24-6313
z/VM: Reusable Server Kernel Programmer's Guide and Reference describes how you can use the reusable server kernel supplied with z/VM to develop and run server programs in the CMS environment. The document covers advanced material in server construction and is not intended for beginning programmers.

z/VM: REXX/VM Reference, SC24-6314
z/VM: REXX/VM Reference provides reference information about REXX instructions and functions and their use. It also provides information about the REXX Sockets API.

z/VM: REXX/VM User's Guide, SC24-6315
z/VM: REXX/VM User's Guide provides step-by-step instructions for using the REXX interpretive command and macrolanguage on z/VM. It is intended for users with some knowledge of z/VM, editors, and terminals, but previous programming experience is not needed.

z/VM: Systems Management Application Programming, SC24-6327
z/VM: Systems Management Application Programming describes the socket-based application programming interface (API) that z/VM provides for performing system management functions for virtual systems (guests) in a z/VM environment.

z/VM: TCP/IP Programmer's Reference, SC24-6332
z/VM: TCP/IP Programmer's Reference, which is intended for users and programmers who are familiar with z/VM and its CP and CMS components, contains information about the following application programming interfaces (APIs):

- z/VM C sockets
- Pascal
- Virtual Machine Communication Facility (VMCF)
- Inter-User Communication Vehicle (IUCV) sockets
- Remote Procedure Calls (RPCs)
- Simple Network Management Protocol (SNMP) agent distributed program interface
- Simple Mail Transfer Protocol (SMTP) virtual machine interfaces
- Telnet exits
- File Transfer Protocol (FTP) exit
- Remote authorization and auditing through LDAP
- Building an LDAP server plug-in

Common Programming Interface Communications Reference, SC26-4399
Common Programming Interface Communications Reference (https://publibfp.dhe.ibm.com/epubs/pdf/c2643999.pdf) describes Systems Application Architecture (SAA) Common Programming Interface (CPI) Communications in detail, including scenarios and individual routines. It is intended for anyone writing an application program that communicates with another program using the APPC protocol. The communications occur within a single TSAF collection, across many TSAF collections, or between a TSAF collection and a SNA network.

Common Programming Interface Resource Recovery Reference, SC31-6821
CPI Resource Recovery Reference describes the Systems Application Architecture (SAA) Common Programming Interface (CPI) resource recovery interface in detail, including scenarios and individual routines. It is intended for programmers who want to write applications that use the SAA resource recovery interface. The SAA resource recovery interface lets programs coordinate exchanges of data and updates to databases and other resources. This coordination ensures that either all changes become permanent or all are undone.

z/OS: IBM Tivoli® Directory Server Plug-in Reference for z/OS, SA76-0169
z/OS: IBM Tivoli Directory Server Plug-in Reference for z/OS (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/glpa300_v3r1.pdf) describes the application services routines that can be used to create plug-ins to extend the capabilities of the z/VM TCP/IP LDAP server. For information about creating LDAP server plug-ins on z/VM, see “z/VM: TCP/IP Programmer's Reference, SC24-6332” on page 78.

z/OS: Language Environment Concepts Guide, SA38-0687
z/OS: Language Environment Concepts Guide (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ceea800_v3r1.pdf) provides information on evaluating and planning for Language Environment.

z/OS: Language Environment Debugging Guide, GA32-0908
z/OS: Language Environment Debugging Guide (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ceea100_v3r1.pdf) provides assistance in detecting and locating programming errors that might occur during run time under Language Environment. The document can help you establish a debugging process to analyze data and narrow the scope and location of where an error might have occurred. You can read about how to prepare a routine for debugging, how to classify errors, and how to use the debugging facilities that Language Environment provides.

z/OS: Language Environment Programming Guide, SA38-0682
z/OS: Language Environment Programming Guide (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ceea200_v3r1.pdf) contains information about linking, running, and using services within Language Environment. It also contains the Language Environment program management model and provides language-specific and operating system-specific information, where applicable.

z/OS: Language Environment Programming Reference, SA38-0683
z/OS: Language Environment Programming Reference (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ceea300_v3r1.pdf) provides a detailed description of each Language Environment runtime option and callable service, as well as information on how to use them. It also provides programming examples that illustrate how each callable service can be used in routines written in Language Environment-conforming high-level languages (HLLs) and assembler language.

z/OS: Language Environment Run-Time Messages, SA38-0686
z/OS: Language Environment Runtime Messages (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ceea900_v3r1.pdf) contains runtime messages and return codes for Language Environment and supported high-level languages.

z/OS: Language Environment Writing Interlanguage Communication Applications, SA38-0684
z/OS: Language Environment Writing Interlanguage Communication Applications (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ceea400_v3r1.pdf) contains information on creating and running interlanguage communication (ILC) applications under Language Environment. ILC applications are applications built of two or more high-level languages (HLLs) and frequently assembler. ILC applications run outside the realm of a single language's environment, which creates special conditions, such as how the languages' data maps across load module boundaries, how conditions are handled, or how data can be called and received by each language.

z/OS MVS Program Management: Advanced Facilities, SA23-1392
z/OS: MVS Program Management Advanced Facilities (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ieab200_v3r1.pdf) contains the programming interfaces provided by the program management component of z/OS. It describes the binder application programming interface, macros, user exits, and buffer formats.

z/OS MVS Program Management: User's Guide and Reference, SA23-1393
z/OS: MVS Program Management User's Guide and Reference (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/ieab100_v3r1.pdf) describes the end user interfaces provided by the program management component of z/OS.

Diagnosis

These publications provide information to help identify, describe, report, and correct a programming problem in a z/VM system.

z/VM: CMS and REXX/VM Messages and Codes, GC24-6255
z/VM: CMS and REXX/VM Messages and Codes describes the messages and codes generated by the CMS and REXX/VM components of z/VM. It explains the conditions that cause each message or code, describes the resulting system action, and suggests the proper user, operator, or programmer response.

z/VM: CP Messages and Codes, GC24-6270
z/VM: CP Messages and Codes describes the messages and codes generated by the CP component of z/VM. It explains the conditions that cause each message or code, describes the resulting system action, and suggests the proper user, operator, or programmer response.

z/VM: Diagnosis Guide, GC24-6280
z/VM: Diagnosis Guide provides diagnostic guidance information to help you identify, report, solve, and collect information about problems that might occur in z/VM.

z/VM: Dump Viewing Facility, GC24-6284
z/VM: Dump Viewing Facility describes how to use the Dump Viewing Facility to interactively diagnose system problems. This facility allows you to display, format, and print data interactively from virtual machine dumps, as well as display and format recorded trace data.

For information on analyzing CP dumps, see z/VM VM Dump Tool.

z/VM: Other Components Messages and Codes, GC24-6300
z/VM: Other Components Messages and Codes describes the messages and codes generated by the AVS, Dump Viewing Facility, GCS, TSAF, and VMSES/E components of z/VM. It explains the conditions that cause each message or code, describes the resulting system action, and suggests the proper user, operator, or programmer response.

For messages issued by the Language Environment component of z/VM, see z/OS: Language Environment Run-Time Messages.

z/VM: TCP/IP Diagnosis Guide, GC24-6328
z/VM: TCP/IP Diagnosis Guide is intended for system programmers who want to diagnose and report problems that might occur in TCP/IP networks.

z/VM: TCP/IP Messages and Codes, GC24-6330
z/VM: TCP/IP Messages and Codes is intended to help system programmers diagnose TCP/IP problems. The document lists TCP/IP messages and codes by category and identifies system actions and user responses.

z/VM: VM Dump Tool, GC24-6335
z/VM: VM Dump Tool describes how to use the VM Dump Tool, which assists in analyzing dump data from a dump file created by the DUMPLOAD and DUMPLD2 utilities. The tool can process CP stand-alone dumps, CP abend dumps, and virtual machine dumps of a CP system. This document describes the VM Dump Tool subcommands and macros that allow you to display, locate, and format dump data interactively.

z/OS and z/VM: Hardware Configuration Definition Messages, SC34-2668
z/OS and z/VM: Hardware Configuration Definition Messages (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/cbdm100_v3r1.pdf) provides explanations of the messages issued by Hardware Configuration Definition (HCD).

Abstracts of the z/VM optional feature publications

There is a set of publications for each of the following z/VM optional features:

- "DFSMS/VM publications" on page 80
- "Directory Maintenance Facility for z/VM publications" on page 81
- "Performance Toolkit for z/VM publications" on page 82
- "RACF Security Server for z/VM publications" on page 82
- "RSCS Networking for z/VM publications" on page 83

DFSMS/VM publications

These publications provide information about the DFSMS/VM optional feature. DFSMS/VM controls data and storage resources.

z/VM: DFSMS/VM Customization, SC24-6274
z/VM: DFSMS/VM Customization provides information on customizing DFSMS/VM to meet the needs of your installation. Topics include:

- Customizing the DFSMS/VM control file
- Using installation-wide exits
- Customizing the Interactive Storage Management Facility (ISMF)
- Performance and tuning

z/VM: DFSMS/VM Diagnosis Guide, GC24-6275
z/VM: DFSMS/VM Diagnosis Guide provides information about diagnosing and reporting DFSMS/VM errors.

z/VM: DFSMS/VM Messages and Codes, GC24-6276
z/VM: DFSMS/VM Messages and Codes contains explanations and suggested actions for messages and codes issued by DFSMS/VM.

z/VM: DFSMS/VM Planning Guide, SC24-6277
z/VM: DFSMS/VM Planning Guide provides information on planning for the installation and use of DFSMS/VM. It can help you make decisions about:

- Using the DFSMS/VM storage management functions in your system
- Authorizing storage administrators
- Setting up the server machines
- Generating accounting records
- Backing up secondary storage

z/VM: DFSMS/VM Removable Media Services, SC24-6278
z/VM: DFSMS/VM Removable Media Services provides information about planning for, using, and customizing the DFSMS/VM Removable Media Services (RMS) subsystem. RMS provides functions that support the IBM 3494 Tape Library Dataserver and IBM 3495 Tape Library Dataserver.

z/VM: DFSMS/VM Storage Administration, SC24-6279
z/VM: DFSMS/VM Storage Administration provides conceptual information on System Managed Storage (SMS) and guides you through the DFSMS/VM storage management and minidisk management operations. It also contains a DFSMS/VM command reference, an ISMF reference, exit information, a DFSMS/VM sample environment, and other useful reference information.

Directory Maintenance Facility for z/VM publications

These publications provide information about the Directory Maintenance Facility for z/VM (DirMaint) optional feature. DirMaint provides interactive facilities for managing the z/VM user directory.

z/VM: Directory Maintenance Facility Commands Reference, SC24-6281
z/VM: Directory Maintenance Facility Commands Reference provides detailed reference information on DirMaint commands. Most of the DirMaint commands have the same name and format as the z/VM directory statements they support. This document also describes the additional utilities that DirMaint provides for minidisk management and command security.

z/VM: Directory Maintenance Facility Messages, GC24-6282
z/VM: Directory Maintenance Facility Messages provides the explanations, failing component names, and suggested corrective actions for the messages issued by DirMaint.

z/VM: Directory Maintenance Facility Tailoring and Administration Guide, SC24-6283
z/VM: Directory Maintenance Facility Tailoring and Administration Guide is the primary source of information about configuring and using DirMaint. It provides information about using DirMaint programming interfaces (for example, user exits), tailoring DirMaint files to accommodate the installation's needs, and administering user IDs and other facilities.

Performance Toolkit for z/VM publications

The following publications provide information about the Performance Toolkit for z/VM optional feature. Performance Toolkit provides tools for analyzing z/VM and Linux performance data.

z/VM: Performance Toolkit Guide, SC24-6302
z/VM: Performance Toolkit Guide describes how Performance Toolkit for z/VM can assist system operators and systems programmers or analysts in the following areas:

- **System operator console operation in full screen mode.** Features are provided to facilitate the operation of VM systems, thereby improving operator efficiency and productivity.
- **Performance monitoring on VM.** An enhanced real-time performance monitor allows systems programmers to monitor system performance and to analyze bottlenecks.

z/VM: Performance Toolkit Reference, SC24-6303
z/VM: Performance Toolkit Reference describes the subcommands and screens provided with Performance Toolkit for z/VM. It also describes the Performance Toolkit messages.

The following publications provide information about z/VM Performance Data Pump, which is licensed with Performance Toolkit for z/VM. z/VM Performance Data Pump (Data Pump) converts machine-readable z/VM monitor and SFS data into a generic text-based data stream. Modern tools can use the data stream to display real-time performance dashboards, aggregate real-time data for long-term usage analysis, or integrate with existing enterprise observability solutions.

z/VM: Performance, SC24-6301
z/VM Performance Data Pump describes how users can set up a virtual service machine for the Data Pump program.

z/VM: Other Components Messages and Codes, GC24-6300
Data Pump Messages describes the Performance Data Pump messages.

RACF Security Server for z/VM publications

These publications provide information about the RACF Security Server for z/VM optional feature. RACF provides data security for an installation by controlling access.

z/VM: RACF Security Server Auditor's Guide, SC24-6305
z/VM: RACF Security Server Auditor's Guide describes the role of the RACF auditor and explains the auditing tools that RACF provides. Reports on system and resource use can provide the auditor with information about the basic system-security environment of an installation.

z/VM: RACF Security Server Command Language Reference, SC24-6306
z/VM: RACF Security Server Command Language Reference describes the syntax and functions of RACF commands.

z/VM: RACF Security Server Diagnosis Guide, GC24-6307
z/VM: RACF Security Server Diagnosis Guide explains how to diagnose problems that might occur in RACF.

z/VM: RACF Security Server General User's Guide, SC24-6308
z/VM: RACF Security Server General User's Guide teaches general users how to use RACF to protect their own minidisks, SFS files, SFS directories, and other general resources. It contains an introduction to RACF and sections that guide the user through basic security tasks.

z/VM: RACF Security Server Macros and Interfaces, SC24-6309
z/VM: RACF Security Server Macros and Interfaces describes the syntax and functions of RACF customization macros. It also contains information about other interfaces such as RACF SMF records and subcodes of CP DIAGNOSE code X'A0'.

For information on the RACROUTE macro and the independent RACF system macros, see z/VM: Security Server RACROUTE Macro Reference.

z/VM: RACF Security Server Messages and Codes, GC24-6310
z/VM: RACF Security Server Messages and Codes describes RACF messages, abend codes, manager return codes, and utility return codes.

z/VM: RACF Security Server Security Administrator's Guide, SC24-6311
z/VM: RACF Security Server Security Administrator's Guide provides information to help the RACF security administrator to:

- Plan how to use RACF, which includes deciding which resources are protected and which users and groups are known to RACF
- Perform daily administration tasks, such as giving users access to the system (assigning user IDs and passwords) and giving users access to system resources or functions
- Coordinate with other administrators, such as the tape librarian

z/VM: RACF Security Server System Programmer's Guide, SC24-6312
z/VM: RACF Security Server System Programmer's Guide provides information for system programmers or installation personnel responsible for:

- Maintaining RACF databases
- Writing, testing, and installing RACF exits
- Modifying RACF to satisfy an installation's particular needs

z/VM: Security Server RACROUTE Macro Reference, SC24-6324
z/VM: Security Server RACROUTE Macro Reference describes the full-function RACROUTE external security interface for z/VM, the requests that can be invoked by it, their respective syntax, and related information. This document is intended for programmers who are writing applications that need to invoke RACF (or another external security manager) from z/VM, or programmers who are writing an external security manager for z/VM.

RSCS Networking for z/VM publications

These publications provide information about the RSCS Networking for z/VM optional feature. RSCS enables users on a z/VM system to send messages, files, commands, and jobs to other users within a network.

z/VM: RSCS Networking Diagnosis, GC24-6316
z/VM: RSCS Networking Diagnosis describes the functions of RSCS and RSCS diagnostic aids and facilities. This document is intended for people who are responsible for isolating and diagnosing any problems that might occur in RSCS operation.

z/VM: RSCS Networking Exit Customization, SC24-6317
z/VM: RSCS Networking Exit Customization describes the RSCS exit facilities. This document describes how you can customize RSCS processing to meet the functional requirements of your facility.

z/VM: RSCS Networking Messages and Codes, GC24-6318
z/VM: RSCS Networking Messages and Codes provides explanations of the messages and abend codes for RSCS and RSCS facilities.

z/VM: RSCS Networking Operation and Use, SC24-6319
z/VM: RSCS Networking Operation and Use explains how to operate RSCS and how to use it to enable your z/VM system to communicate with other systems. This document describes how to send data across the network, how to define and manage links, and how to automate your network. It explains how to operate and use the RSCS server, RSCS domain name server, RSCS dynamic authorization, and the RSCS Data Interchange Manager. This document also describes the syntax and functions of the RSCS commands and link operational parameters and the commands for the other RSCS facilities.

z/VM: RSCS Networking Planning and Configuration, SC24-6320
z/VM: RSCS Networking Planning and Configuration provides a high-level description of RSCS and provides information to help you plan for your RSCS network. This document describes planning tasks for RSCS configuration, operation, administration, and diagnosis. It also describes the syntax and functions of the configuration file statements for the various types of RSCS servers.

z/OS: Network Job Entry (NJE) Formats and Protocols, SA32-0988
z/OS: Network Job Entry (NJE) Formats and Protocols (https://www.ibm.com/docs/en/SSLTBW_3.1.0/pdf/hasa600_v3r1.pdf) explains the Network Job Entry (NJE) formats and protocols used by program products that support networking.

Appendix A. IBM servers supported by z/VM

This topic provides information about the IBM servers supported by current releases of z/VM. For guest considerations, see Appendix B, “IBM Z–compatible operating systems supported as guests of z/VM ,” on page 95.

The following general notes apply to the support matrix (Table 2 on page 86):

End of Service (EoS) or Withdrawal from Marketing

- z/VM 6.2 achieved EoS on June 30, 2017.
- z/VM 5.4 and 6.3 achieved EoS on December 31, 2017.
- z/VM 6.4 achieved EoS on March 31, 2021.
- z/VM 7.1 achieved EoS on March 31, 2023.
- z/VM 7.2 achieved EoS on March 31, 2025.

z/VM releases no longer supported have been removed from the matrix.

Processor Resource/Systems Manager (PR/SM) support
The Processor Resource/Systems Manager (PR/SM) hardware feature supports the creation of multiple logical partitions (LPARs) on a single central processor complex (CPC), dividing server resources across the LPARs. Each LPAR supports an independent operating system. z/VM supports the following LPAR types (modes):

- General (on IBM z14 family and later servers, excluding LinuxONE servers)
- LINUX only
- z/VM

Specialty-processor guest-use support
z/VM supports guest use of IBM mainframe specialty processors:

- IBM Integrated Facility for Linux (IFL)
- IBM Internal Coupling Facility (ICF)
- IBM z Integrated Information Processor (zIIP)

Linux-only LPAR support
A Linux-only LPAR, whether the allocated processors are IFL processors or general purpose processors, will not support any of the IBM traditional operating systems (such as z/OS, z/TPF, or 21CS VSE^{n}). Only Linux on IBM Z or z/VM can run in a LINUX-only LPAR.

IFL processor support

- An IFL processor can be defined only in a Linux-only or z/VM LPAR.
- z/VM may run on IFL processors only if, on the IFL processors, z/VM is being used exclusively to run (1) Linux workloads and, (2) if required, z/VM applications in support of those Linux workloads.

Integrated 3270 console task support
To use the integrated 3270 console task on the Hardware Management Console as a system operator console for z/VM, the server must be running at the current Licensed Internal Code (LIC) level with the Hardware Management Console at V2.13 or later.

Servers and hypervisor support:
For supported servers and hypervisors, see Table 2 on page 86.

Notes:

1. PTFs may be required; see the details in these topics:
   - “Server support: IBM z17 family” on page 87
   - “Server support: IBM z16 family” on page 89

- "Server support: IBM z15 family" on page 91
- "Server support: IBM z14 family" on page 93

2. The inclusion of a server in the server support tables does not imply that the server is available in all countries.
3. For information about IBM servers and z/VM releases not listed in the server support tables, see the previous editions of this document.

Table 2. IBM LinuxONE models; corresponding IBM Z models; links to respective z/VM software requirements web pages (replacing Preventive Service Planning [PSP] buckets, which are being sunset); and z/VM releases that can be selected as hypervisors.

IBM LinuxONE model	IBM Z model on which this IBM LinuxONE model is based	Server web page listing z/VM software requirements (See table note.)	z/VM release that can be selected as the hypervisor
IBM LinuxONE Emperor 5 ML1	IBM z17 ME1 See "Server support: IBM z17 family" on page 87 .	z/VM service required for the IBM z17 family servers (https://www.vm.ibm.com/service/vmreqz17.html).	7.4, 7.3
IBM LinuxONE Emperor 4 LA1	IBM z16 A01 See "Server support: IBM z16 family" on page 89.	z/VM service required for the IBM z16 family servers (https://www.vm.ibm.com/service/vmreqz16.html)	7.4, 7.3
IBM LinuxONE Rockhopper 4 AGL	IBM z16 AGZ See "Server support: IBM z16 family" on page 89.	z/VM service required for the IBM z16 family servers (https://www.vm.ibm.com/service/vmreqz16.html)	7.4, 7.3
IBM LinuxONE Rockhopper 4 LA2	IBM z16 A02 See "Server support: IBM z16 family" on page 89.	z/VM service required for the IBM z16 family servers (https://www.vm.ibm.com/service/vmreqz16.html)	7.4, 7.3
IBM LinuxONE III LT1 (Machine type 8561)	IBM z15 T01 See "Server support: IBM z15 family" on page 91.	z/VM service required for the IBM z15 family servers (https://www.vm.ibm.com/service/vmreqz15.html)	7.4, 7.3
IBM LinuxONE III LT2 (Machine type 8562)	IBM z15 T02 See "Server support: IBM z15 family" on page 91.	z/VM service required for the IBM z15 family servers (https://www.vm.ibm.com/service/vmreqz15.html)	7.4, 7.3

Table 2. IBM LinuxONE models; corresponding IBM Z models; links to respective z/VM software requirements web pages (replacing Preventive Service Planning [PSP] buckets, which are being sunset); and z/VM releases that can be selected as hypervisors. (continued)

IBM LinuxONE model	IBM Z model on which this IBM LinuxONE model is based	Server web page listing z/VM software requirements (See table note.)	z/VM release that can be selected as the hypervisor
IBM LinuxONE III Express	IBM z15 T02 See "Server support: IBM z15 family" on page 91.	z/VM service required for the IBM z15 family servers (https://www.vm.ibm.com/service/vmreqz15.html)	7.4, 7.3
IBM LinuxONE Emperor II	IBM z14 See "Server support: IBM z14 family" on page 93.	IBM: Service Required for Running on the IBM z14 (https://www.vm.ibm.com/service/vmreqz14.html)	7.3
IBM LinuxONE Rockhopper II	IBM z14 ZR1 See "Server support: IBM z14 family" on page 93.	IBM: Service Required for Running on the IBM z14 (https://www.vm.ibm.com/service/vmreqz14.html)	7.3

Table note: Before installing z/VM, refer to the server web page containing the specific z/VM software requirements.

Server support: IBM z17 family

The following are general support notes for the IBM z17 family of servers:

LPAR support

The following LPAR modes are supported:

- General
- LINUX only
- z/VM

The maximum number of LPARs that is supported is 85.

Memory support and requirements

The following maximum amounts of memory are supported:

- Up to 4 TB of real storage (memory) per z/VM image.
- Up to 2 TB of virtual memory for a single guest on z/VM.

The total virtual memory in use by all guests can exceed the amount of real memory. See "Maximum memory limits and minimum memory requirements" on page 112 and accompanying note 6.

Guest IPL from SCSI, with or without the DUMP option, requires a minimum virtual memory size of 768MB.

Logical processor support

The following maximum numbers of logical processors are supported:

- Up to 80 logical processors per z/VM image.

- Up to 64 virtual processors per virtual machine in each z/VM image.

z/Architecture guest use support

z/Architecture guest use of the following is supported:

- Crypto Express8S
- Crypto Express7S
- Crypto Express6S

Installing z/VM on an IBM z17 family server

When installing z/VM on IBM z17 family servers:

- z/VM can be installed directly on an IBM z17 family server.
- Installation of z/VM from an IBM z17 family USB flash drive is supported. Information about receiving z/VM product deliverables electronically can be found at Installation Instructions for Electronically Delivered z/VM System Deliverable and Licensed Products (https://www.vm.ibm.com/install/prodinst.html)

Upgrading to an IBM z17 family server

If you are upgrading to a server in the IBM z17 family from an IBM z13® family or earlier server, you must update the Stand-Alone Program Loader (SAPL), or you will not be able to IPL z/VM. For more information, see the red alert issued December 13, 2017 at z/VM Service: Red Alerts (https://www.vm.ibm.com/service/redalert/#SAPLZ14).

APAR requirements

If an APAR is required for a z/VM release to support a function on a particular server, that APAR is also required for the same z/VM release to support the same function on a newer server.

The following table provides the release-specific z/VM APARs that are required to support functions available on IBM z17 family servers.

Table 3. z/VM APARs required to support functions available on IBM z17 family servers

Functions available on the IBM z17 family of servers	**z/VM 7.4 requirement**	**z/VM 7.3 requirement**
For the list of functions available with these APARs, see "[7.4, 7.3 APARs] z/VM support for the IBM z17 family" on page 14.	PTFs for APARs: VM66824, VM66854, and VM66877 (CP) VM66858 (RACF)	PTFs for APARs: VM66823, VM66853, and VM66878 (CP); VM66857 (RACF)
TCP/IP enhanced QDIO (EQDIO) device driver	PTFs for APARs: PH65378 and PH67661	PTFs for APARs: PH65377 and PH67660
Enhanced QDIO (EQDIO) API support	PTF for APAR VM66828	PTF for APAR VM66822
Performance Data Pump power metric dashboard	PTF for APAR VM66826	PTF for APAR VM66825
CMS IOCP **Note:** With the IOCP support for the IBM z17 family applied, z/CMS support is now required by z/VM IOCP on any IBM z or IBM LinuxONE server.	PTF for APAR VM66827	PTF for APAR VM66741

Table 3. z/VM APARs required to support functions available on IBM z17 family servers (continued)		
Functions available on the IBM z17 family of servers	**z/VM 7.4 requirement**	**z/VM 7.3 requirement**
HCD support for IBM z17 model ME1 **Note:** z/CMS and z/XC support must be configured for the one guest that is defined to exploit z/VM HCD support.	PTF for APAR VM66824	PTF for APAR VM66788
HCD support for IBM LinuxONE Emperor 5 model ML1 **Note:** z/CMS and z/XC support must be configured for the one guest that is defined to exploit z/VM HCD support.	PTF for APAR VM66824	PTF for APAR VM66789
HCM support for IBM z17 model ME1.	PTF for APAR VM66824	PTF for APAR VM66836
HLASM	PTF for APAR PH62834	PTF for APAR PH62834
z/VM Agent for TDMF for z/OS	PTF for APAR VM66852	PTF for APAR VM66852

Server support: IBM z16 family

The following are general support notes for the IBM z16 family of servers:

LPAR support

The following LPAR modes are supported:

- General
- LINUX only
- z/VM

The maximum number of LPARs that is supported is 85.

Memory support and requirements

The following maximum amounts of memory are supported:

- Up to 4 TB of real storage (memory) per z/VM image.
- Up to 2 TB of virtual memory for a single guest on z/VM.

The total virtual memory in use by all guests can exceed the amount of real memory. See “Maximum memory limits and minimum memory requirements” on page 112 and accompanying note 6.

Guest IPL from SCSI, with or without the DUMP option, requires a minimum virtual memory size of 768MB.

Logical processor support

The following maximum numbers of logical processors are supported:

- Up to 80 logical processors per z/VM image.
- Up to 64 virtual processors per virtual machine in each z/VM image.

z/Architecture guest use support

z/Architecture guest use of the following is supported:

- Crypto Express8S
- Crypto Express7S
- Crypto Express6S.

Installing z/VM on a IBM z16 family server

When installing z/VM on IBM z16 family servers:

- z/VM can be installed directly on the IBM z16 family.
- Installation of z/VM from the IBM z16 family USB flash drive is supported. Information about receiving z/VM product deliverables electronically can be found at Installation Instructions for Electronically Delivered z/VM System Deliverable and Licensed Products (https://www.vm.ibm.com/install/prodinst.html)

Upgrading to an IBM z16 family server

If you are upgrading to a server in the IBM z16 family from an IBM z13 family or earlier server, you must update the Stand-Alone Program Loader (SAPL), or you will not be able to IPL z/VM. For more information, see the red alert issued December 13, 2017 at z/VM Service: Red Alerts (https://www.vm.ibm.com/service/redalert/#SAPLZ14).

APAR requirements

If an APAR is required for a z/VM release to support a function on a particular server, that APAR is also required for the same z/VM release to support the same function on a newer server.

The following table provides the release-specific z/VM APARs that are required to support functions available on IBM z16 family servers.

Table 4. z/VM APARs required to support functions available on IBM z16 family servers

Functions available on IBM z16 family servers	**z/VM 7.4 requirement**	**z/VM 7.3 requirement**
Enables guests to exploit the following functions: • Imbedded Artificial Intelligence Acceleration • Compliance-ready Central Processor Assist for Cryptographic Functions (CPACF) counters support • Breaking-event-address register (BEAR) enhancement facility • Vector Packed Decimal Enhancements 2 • Reset DAT Protection Facility • Consolidated Boot Loader, providing guest IPL from a SCSI LUN. (See “Memory support and requirements” on page 89.) • RoCE Express3 adapter • IBM Adapter for NVMe 1.1 (IBM LinuxONE Emperor 4 only) • Crypto Express8S (CEX8S) adapter	Base	Base
CPU and core topology location information, which is included in z/VM monitor data	Base	Base
EREP	Not supported	Base
IPL support for ICKDSF	Base	Base
CMS IOCP **Note:** With the IOCP support for IBM z16 family applied, z/CMS support is now required by z/VM IOCP on any IBM z or IBM LinuxONE server.	Base	PTFs for APARs VM66549 and VM66629

Table 4. z/VM APARs required to support functions available on IBM z16 family servers (continued)

Functions available on IBM z16 family servers	z/VM 7.4 requirement	z/VM 7.3 requirement
HCD support for IBM z16 model A01 **Note:** z/CMS and z/XC support must be configured for the one guest that is defined to exploit z/VM HCD support.	Part of HCD executables are included in CP base.	Base
HCD support for IBM LinuxONE Emperor 4 model LA1 **Note:** z/CMS and z/XC support must be configured for the one guest that is defined to exploit z/VM HCD support.	Part of HCD executables included in CP base.	PTF for APAR VM66554
HCD support for: • IBM z16 models A02 and AGZ • IBM LinuxONE Rockhopper 4 models LA2 and AGL **Note:** z/CMS and z/XC support must be configured for the one guest that is defined to exploit z/VM HCD support.	Part of HCD executables included in CP base.	PTF for APAR VM66624
HCM	Part of HCD executables included in CP base.	Base
HLASM	PTF for APAR PH39324	PTF for APAR PH39324
OSA-Express7S within TCP/IP	Base	Base
Guest secure IPL (load and dump) for both ECKD and SCSI devices **Note:** This requires an IBM z16 family server with driver D51C Bundle S19 applied.	Base	PTFs for APARs VM66434 (CP), VM66424 (DirMaint), and VM66650 (SMAPI)
Crypto stateless-command filtering **Note:** This requires an IBM z16 family server with driver D51C Bundle S19 applied.	Base	PTF for APAR VM66423
Security settings and compliance interfaces	Base	PTF for APAR VM66646

Server support: IBM z15 family

The following are general support notes for the IBM z15 family of servers:

LPAR support

The following LPAR modes are supported:

- General
- LINUX only
- z/VM

The maximum number of LPARs that is supported is 85.

Memory support and requirements

The following maximum amounts of memory are supported:

- Up to 4 TB of real storage (memory) per z/VM image.
- Up to 2 TB of virtual memory for a single guest on z/VM.

The total virtual memory in use by all guests can exceed the amount of real memory. See "Maximum memory limits and minimum memory requirements" on page 112 and accompanying note 6.

Guest IPL from SCSI, with the DUMP option, requires a minimum virtual memory size of 512MB.

Logical processor support

The following maximum numbers of logical processors are supported:

- Up to 80 logical processors per z/VM image.
- Up to 64 virtual processors per virtual machine in each z/VM image.

z/Architecture guest use support

z/Architecture guest use of the following is supported:

- Crypto Express7S
- Crypto Express6S
- Crypto Express5S

Installing z/VM on an IBM z15 family server

When installing z/VM on IBM z15 family servers:

- z/VM can be installed directly on the IBM z15 family.
- Installation of z/VM from the z15 family USB flash drive is supported. Information about receiving z/VM product deliverables electronically can be found at Installation Instructions for Electronically Delivered z/VM System Deliverable and Licensed Products (https://www.vm.ibm.com/install/prodinst.html)

Upgrading to an IBM z15 family server

If you are upgrading to a server in the IBM z15 family from an IBM z13 family or earlier server, you must update the Stand-Alone Program Loader (SAPL), or you will not be able to IPL z/VM. For more information, see the red alert issued December 13, 2017 at z/VM Service: Red Alerts (https://www.vm.ibm.com/service/redalert/#SAPLZ14).

APAR requirements

If an APAR is required for a z/VM release to support a function on a particular server, that APAR is also required for the same z/VM release to support the same function on a newer server.

The following table provides the release-specific z/VM APARs that are required to support functions available on IBM z15 family servers.

Table 5. z/VM APARs required to support functions available on IBM z15 family servers

Functions available on IBM z15 family servers	**z/VM 7.4 requirement**	**z/VM 7.3 requirement**
Enables guests to exploit the following functions: • Miscellaneous-Instruction-Extensions Facility 3 • Vector Enhancements Facility 2 • Vector Packed Decimal Enhancement Facility • Synchronous Execution Support for On-chip Data Compression, Deflate-Conversion • Enhanced Sort Acceleration and Optimization • Message-Security-Assist Extension 9 • Crypto Express7S adapter	Base	Base
Support for System Recovery Boost is provided in the base of z/VM. Not applicable to LinuxONE III.	Base	Base

Table 5. z/VM APARs required to support functions available on IBM z15 family servers (continued)

Functions available on IBM z15 family servers	z/VM 7.4 requirement	z/VM 7.3 requirement
EREP	Not supported	Base
IPL support for ICKDSF	Base	Base
CMS IOCP	Base	Base
HCD support for these IBM z15 models: • Model T01 • Model LT1 • Model T02 • Model LT2	HCD executables included in CP base	Base
HCM	Base	Base
HLASM	PTF for APAR PH00902	PTF for APAR PH00902
OSA-Express7S within TCP/IP	Base	Base

Server support: IBM z14 family

The following are general support notes for the IBM z14 family of servers:

LPAR support

The following LPAR modes are supported:

- General
- LINUX only
- z/VM

The maximum number of LPARs that is supported is 85.

Memory support and requirements

The following maximum amounts of memory are supported:

- Up to 4 TB of real storage (memory) per z/VM image.
- Up to 2 TB of virtual memory for a single guest on z/VM.

The total virtual memory in use by all guests can exceed the amount of real memory. See "Maximum memory limits and minimum memory requirements" on page 112 and accompanying note 6.

Logical processor support

The following maximum numbers of logical processors are supported:

- Up to 80 logical processors per z/VM image.
- Up to 64 virtual processors per virtual machine in each z/VM image.

z/Architecture guest use support

z/Architecture guest use of the following is supported:

- Crypto Express6S
- Crypto Express5S

Upgrading to an IBM z14 family server

- If you are upgrading to a server in the IBM z14 family from an IBM z13 family or earlier server, you must update the Stand-Alone Program Loader (SAPL), or you will not be able to IPL z/VM. For

more information, see the red alert issued December 13, 2017 at z/VM Service: Red Alerts (https://www.vm.ibm.com/service/redalert/#SAPLZ14).

Performing a concurrent driver upgrade

When performing a concurrent driver upgrade from driver D32 to driver D36, to avoid a loss of network connectivity from within z/VM LPARs, ensure that the target driver D36 bundle is 19a or higher.

APAR requirements

If an APAR is required for a z/VM release to support a function on a particular server, that APAR is also required for the same z/VM release to support the same function on a newer server.

The following table provides the release-specific z/VM APARs that are required to support functions available on IBM z14 family servers.

Table 6. z/VM APARs required to support functions available on IBM z14 family servers

Functions available on IBM z14 family servers	**z/VM 7.3 requirement**
EREP	Base
ICKDSF IPL support	PTF for APAR PI46151
ICKDSF support for EAV minidisk	PTF for APAR PI85943

Appendix B. IBM Z–compatible operating systems supported as guests of z/VM

This topic provides information about the IBM Z–compatible operating systems supported as guests of current z/VM releases.

In general, an operating system is supported as a guest of z/VM only where support has been announced for that operating system to run on the server. For example, if an operating system is not supported to run in a LINUX only LPAR, that operating system is not supported as a guest of z/VM running in a LINUX only LPAR.

This topic is not intended to completely cover the complex issues involved in hardware support. For server considerations, see Appendix A, “IBM servers supported by z/VM,” on page 85.

The following general notes apply to the support matrix:

End of Service (EoS) or Withdrawal from Marketing

- z/VM 6.2 achieved EoS on June 30, 2017.
- z/VM 5.4 and 6.3 achieved EoS on December 31, 2017.
- z/VM 6.4 achieved EoS on March 31, 2021.
- z/VM 7.1 achieved EoS on March 31, 2023.
- z/VM 7.2 achieved EoS on March 31, 2025.

z/VM releases no longer supported have been removed from the matrix.

Table 7. Guest support

Guest of z/VM 7.4 or 7.3 host	**Support notes**
Linux on IBM Z	Tested platforms for Linux (https://www.ibm.com/support/pages/node/6191619) shows IBM tested and supported Linux environments on IBM servers. A supported Linux distribution is also supported as a guest of z/VM if the z/VM release supports that server.
z/OS V2.1 or later	1. Exploitation of hardware function by z/OS might require specific levels of z/VM. For details, see *z/OS: Planning for Installation*, GA22-7504. 2. z/VM supports only virtual coupling. 3. Exploiting zCX in a z/OS virtual machine (zCX on z/OS as a guest of z/VM, similar to "second-level") is functionally supported but is intended only for testing purposes for the guest z/OS system and its zCX containers. Performance of the containerized applications will not compare favorably to what would be achieved running those workloads on native z/OS.
z/TPF V1.1	1. z/TPF is supported as a guest of z/VM in environments where TPF-specific server and DASD control unit RPQs are not required. Use of the Emulation Program for 37xx communication controllers is not supported. 2. z/VM System Recovery Boost support benefits the z/TPF guest environment when running on IBM z15 and later servers.

Table 7. Guest support (continued)

Guest of z/VM 7.4 or 7.3 host	Support notes
21CS VSE^{n} 6.3 or later	1. z/VSE has achieved end of life and has been replaced by 21CS VSE^{n}. Support for 21CS VSE^{n} is provided by 21CS. For more information, see 21CS website. 2. z/VM System Recovery Boost support benefits the 21CS VSE^{n} guest environment when running on IBM z15 and later servers.
z/VM	1. Running z/VM in a virtual machine (z/VM as a guest of z/VM, also known as "second-level") is functionally supported but is intended only for testing purposes for the second-level z/VM system and its guests (called "third-level" guests). Performance of the third-level guests will not compare favorably to what would be achieved running those guest workloads second-level. 2. z/VM Guest Coupling Simulation is not supported in the z/VM guest.

Appendix C. IBM devices supported by z/VM

This topic provides information about the IBM devices supported by current releases of z/VM.

The device support matrix is intended to provide a quick reference for support of various devices on z/VM. You should also check the hardware device support list for your server to be sure the hardware supports a particular device. Other devices not found in the device support matrix might be supported; consult IBM hardware announcements and device documentation for this information.

Device support might not be in the base z/VM release, but might have been delivered through the service stream by the PTF for an APAR.

Devices are fully supported by z/VM unless otherwise indicated. z/VM supports devices at any of the following three levels of function:

1. **Full support:** z/VM uses the device itself and makes it available to guests. z/VM will usually manage the device on behalf of all users.
2. **Dedicated to a guest or virtual machine:** z/VM does not use the device itself but enables guests or applications in virtual machines to use the device. There are usually no restrictions on the use of the device by a guest or application, except that the device may not be dedicated to more than one virtual machine at a time.
3. **Dedicated to a guest or virtual machine as an unsupported device:** z/VM does not use the device itself but enables guests or applications in virtual machines to use the device. The guest or application is completely responsible for the management and use of the device. Usage restrictions might apply; the major common usage restriction for this type of support is that the device cannot be used as the guest's IPL device.

The device support matrix might show that support for a device was not provided after a particular z/VM release. The following clarifications on the meaning of the programming support withdrawal might be helpful:

- Where programming support for a *real* device has been withdrawn as of some z/VM release, the corresponding *virtual* device remains supported in the same or later z/VM releases.
- There are some device types which can be defined as, or use many of the device attributes of, the real devices for which programming support is being terminated. z/VM support for these currently supported devices remains unchanged.

Additional device restrictions might apply. There might be exceptions to supported devices and releases depending on your specific configuration. See *z/VM: CP Planning and Administration* for your release and applicable IBM hardware announcements.

It is sometimes possible to define a device differently depending on whether the definition is done using the system configuration file or dynamic I/O configuration support. For instance, a 3745 Communications Controller would be defined as a 3705 Communications Controller using the system configuration file but as a 3745 Communications Controller using dynamic I/O configuration. For information about the system configuration file, see *z/VM: CP Planning and Administration*. For information about dynamic I/O configuration, see *z/VM: I/O Configuration*.

The following general notes apply to the matrix:

End of Service (EoS) or Withdrawal from Marketing

- z/VM 6.2 achieved EoS on June 30, 2017.
- z/VM 5.4 and 6.3 achieved EoS on December 31, 2017.
- z/VM 6.4 achieved EoS on March 31, 2021.
- z/VM 7.1 achieved EoS on March 31, 2023.
- z/VM 7.2 achieved EoS on March 31, 2025.

z/VM releases no longer supported have been removed from the matrix.

Earlier devices and z/VM releases

For information about IBM devices and z/VM releases not listed in this matrix, see the previous editions of this document.

Problems with OEM devices

If a z/VM-related problem occurs with an OEM device that is equivalent to a supported IBM device listed in this section, IBM will fix the problem if it can be recreated with the corresponding IBM device. Customers should always contact the OEM manufacturer first about any problem encountered with an OEM device to find out if it is a known OEM problem.

Direct access storage devices (DASD)

Table 8. Device support: DASD

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
System Storage DS8000 series (2107) [FICON attached]	All	z/VM automatically virtualizes the controller mode that a guest supports. Supported in 2107 native controller mode. Supported in emulation mode as a 3990 Model 3 or 6 Storage Control with the following DASD device types: • 3390 Model 2, 3, 9 (including large Model 9s known as Model 27 and Model 54), and Model A (EAV) DASD. • 3390 Model 2 and 3 DASD in 3380 track compatibility mode 3390 volumes with a minimum size of 10016 cylinders or FBA devices with a minimum size of 6 GB are supported for installation of z/VM. Dynamic volume expansion is supported. Extended address 3390-A devices are supported. Performance-oriented track level commands supported for guest use only. Parallel Access Volumes (PAVs) supported as minidisks for guests that exploit PAV architecture. Included in base: On FICON-attached DS8000, HyperPAV volumes supported as fullpack minidisks, or 1-END minidisks, for guests that exploit this PAV architecture. DFSMS/VM FL221 support for 3390 Model 9 disks larger than 10017 cylinders requires APAR VM63004. For guest use of FlashCopy, the device must be dedicated to the guest or defined as a fullpack minidisk. PPRC supported for guest use only. Native use of PPRC requires ICKDSF V1.17. For ICKDSF support information, see the ICKDSF Program Directory.
System Storage DS8000 series (2107) [FCP attached]	All	For native z/VM use, the DS8000 volumes appear as 9336-20 DASD. For guest use, the DS8000 volumes can appear either as 9336-20 DASD or as SCSI LUNs directly accessed through FCP subchannels. DFSMS/VM FL221 support for SCSI LUNs larger than 381 GB requires APAR VM63664.

Table 8. Device support: DASD (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
DS8882F	7.3	Can be plugged into a z14 ZR1 or LinuxONE Rockhopper II.
DS8900F	All	All current z/VM releases support the DASD. Endpoint Security is supported on the IBM z15 Model T01, IBM LinuxONE III Model LT1, and IBM z16 family.
XIV® Storage System	All	
FlashSystem	All	Can be directly attached for system and EDEV use without requiring a SAN Volume Controller (SVC).

DASD control units and storage controls

Table 9. Device support: DASD control units and storage controls

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
SAN Volume Controller 2145	All	
Storwize V7000	All	

Tape units and tape libraries

Table 10. Device support – tape units and tape libraries

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
3490E (Enhanced Capability Model) Tape Subsystem	All	Not supported for installation of z/VM.
TotalStorage Enterprise Tape System (3590)	All	DFSMS/VM FL221 support for the 3590 Model H requires APAR VM63097. Not supported for installation of z/VM.

Table 10. Device support – tape units and tape libraries (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
System Storage 3592 TS1120 (E05), TS1130 (E06), and TS1140 (E07) Tape Drives	All	z/VM native tape functions (such as SPXTAPE, DUMP, CMS TAPE) supported with FICON Controller Attachment only. z/VM supports drive-based data encryption, including rekey support. Not supported for installation of z/VM. DFSMS/VM FL221 requires: • APAR VM63353 for basic device support. • APAR VM63460 to support Write Once Read Many (WORM) media. • APAR VM64458 to support the 3592 Model E06. • APAR VM65005 to support the 3592 Model E07.
IBM Virtualization Engine TS7700 (Models TS7720 and TS7740)	All	Native z/VM tape library support is provided by DFSMS/VM FL221 with PTFs for RMS APARs VM64773 and VM65005 (and prerequisite service). DFSMS/VM APAR VM65789 is required for RMS Copy Export support. Not supported for installation of z/VM.

Tape control units

Table 11. Device support: Tape control units

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
System Storage TS1120 Tape Controller Model C06	All	
System Storage Tape Controller Model C07	All	

Printers

Table 12. Device support: Printers

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
3203 Model 5	All	
3262	All	

Table 12. Device support: Printers (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
3268 Model 2, 2C	All	Must be defined as a 3287.
3287 Model 1, 1C, 2, 2C, 4	All	
3289 Model 1, 3, 4, 8	All	
3800 Model 1	All	
3800 Model 3, 6, 8	All	Full support in Model 1 compatibility mode or using Advanced Function Printing (AFP) programs.
3820	All	Full support through ACF/VTAM V4.2, using AFP programs.
3900	All	Must be defined as a 3800.
4245 Model 1	All	Supported as a 4245 or in 3262 compatibility mode.
4248 Model 1, 2	All	Supported as a 4248 or in 3211 compatibility mode.
6262 Model 14, 22	All	Must be defined as a 4248 Model 1.

Terminals, displays, and consoles

Most terminals are supported as a virtual machine console (in 3215 emulation mode or 3270 mode). 3270-family displays can be defined generically (for example, as 3270s) with dynamic computation of screen size based on information returned from the device.

z/VM also supports the integrated 3270 console and integrated ASCII console functions of the Hardware Management Console.

Display printers

Most display printers are supported using Advanced Function Printing (AFP) programs through RSCS.

Display control units

Table 13. Device support: Display control units

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
3174	All	
3272 Model 2	All	
3274	All	

Communications controllers

Table 14. Device support: Communications controllers

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
3745	All	Must be dedicated to a virtual machine as a supported device. Must be defined as a 3705, unless you are using dynamic system configuration.

Switches

Table 15. Device support – switches

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
2032 FICON Director Model 1	All	

Server features and miscellaneous devices

Table 16. Device support: Server features and miscellaneous devices

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
Channel-to-Channel Adapter (CTCA)	All	Must be dedicated to a virtual machine as a supported device.
Coupling Express Long Reach (CE LR)	All	Supported on z14/z14 ZR1. Not supported on LinuxONE. CHPID type is CL5.
Coupling Express2 Long Reach (CE LR)	All	Supported on IBM z16 family. CHPID type is CL5.
Crypto Express5S	All	Supported on IBM z14 and z15. Must be configured for shared or dedicated access by a virtual machine in z/Architecture mode.
Crypto Express6S	All	Supported on IBM z14 family or later. Must be configured for shared or dedicated access by a virtual machine in z/Architecture mode.
Crypto Express7S	All	Supported on IBM z15 family or later. Must be configured for shared or dedicated access by a virtual machine in z/Architecture mode.

Table 16. Device support: Server features and miscellaneous devices (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
Crypto Express8S	All	Supported on IBM z16 family. Must be configured for shared or dedicated access by a virtual machine in z/Architecture mode.
FCP Express32S	All	Supported on LinuxONE II with driver D36, and LinuxONE III.
FICON Express8S	All	Supported on IBM z14 family and z15 family. Guest CTCA support requires a dedicated device.
FICON Express16S	All	Supported on IBM z14 family and z15 family. Guest CTCA support requires a dedicated device.
FICON Express16S+	All	Supported on IBM z14 family or later. Guest CTCA support requires a dedicated device.
FICON Express16SA	All	Supported on z15 Model T01, LinuxONE III Model LT1, and IBM z16 family. Guest CTCA support requires a dedicated device.
FICON Express32S	All	Supported on IBM z16 family. Guest CTCA support requires a dedicated device.
FICON Express32G-4P	All	Supported on IBM z17 family. Guest CTCA support requires a dedicated device.
HiperSockets	All	Must be dedicated to a virtual machine as a supported device.
IBM Adapter for NVMe	All	Supported on LinuxONE II with driver D36, and LinuxONE III. Must be dedicated to a virtual machine as a supported device or defined as a 9336 Model 20.
IBM Adapter for NVMe 1.1	All	Supported on IBM LinuxONE Emperor 4 and Rockhopper 4. Must be dedicated to a virtual machine as a supported device or defined as a 9336 Model 20.

Table 16. Device support: Server features and miscellaneous devices (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
Network Express	All	Supported on the IBM z17 family or later family of servers. z/VM supports two ports per adapter on 10 Gigabit Ethernet and 25 Gigabit Ethernet Adapters, which can be configured for OSH and NETH devices. Must be dedicated to a virtual machine as a supported device. z/VM supports isolation of EQDIO data connection communication on a shared Network Express port in support of multitier security zones. For additional information on the capabilities of this Network Express feature, consult IBM Z Connectivity Handbook (https://www.redbooks.ibm.com/abstracts/sg245444.html).
OSA-Express4S	All	Supported on IBM z14 family (1000BASE-T only). Must be dedicated to a virtual machine as a supported device. z/VM supports two ports per adapter on the Gigabit Ethernet and 1000BASE-T Ethernet adapters, and one port per adapter on the 10 Gigabit Ethernet adapters. z/VM supports isolation of QDIO data connection communication on a shared OSA-Express4S port in support of multitier security zones. OSA/SF on the HMC is required to customize the OSA-Express4S modes. For additional information on the capabilities of this OSA Express feature, consult IBM Z Connectivity Handbook (https://www.redbooks.ibm.com/abstracts/sg245444.html).

Table 16. Device support: Server features and miscellaneous devices (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
OSA-Express5S	All	Supported on IBM z14 family. Must be dedicated to a virtual machine as a supported device. z/VM supports two ports per adapter on the Gigabit Ethernet and 1000BASE-T Ethernet adapters, and one port per adapter on the 10 Gigabit Ethernet adapters. z/VM supports isolation of QDIO data connection communication on a shared OSA-Express5S port in support of multitier security zones. OSA/SF on the HMC is required to customize the OSA-Express5S modes. For additional information on the capabilities of this OSA Express feature, consult IBM Z Connectivity Handbook (https://www.redbooks.ibm.com/abstracts/sg245444.html).
OSA-Express6S	All	Supported on IBM z14 family, IBM z15 family, and IBM z16 family. Must be dedicated to a virtual machine as a supported device. z/VM supports two ports per adapter on the Gigabit Ethernet and 1000BASE-T Ethernet adapters, and one port per adapter on the 10 Gigabit Ethernet adapters. z/VM supports isolation of QDIO data connection communication on a shared OSA-Express6S port in support of multitier security zones. OSA/SF on the HMC is required to customize the OSA-Express6S modes. For additional information on the capabilities of this OSA Express feature, consult IBM Z Connectivity Handbook (https://www.redbooks.ibm.com/abstracts/sg245444.html).

Table 16. Device support: Server features and miscellaneous devices (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
OSA-Express7S	All	OSA-Express7S 25GbE is supported on IBM z14 family Driver 36 with Bundle 17a or higher, IBM z15 family servers, and IBM z16 family servers. OSA-Express7S GbE and 10GbE are supported on IBM z15 family servers and IBM z16 family servers. These OSA Exp7S cards are available as carry-forward (CF) cards on a z17 from the z15. 1000Base-T is supported on IBM z15 family servers and IBM z16 family servers. 1000Base-T configured as OSD is supported on IBM z17 family servers. Must be dedicated to a virtual machine as a supported device. z/VM supports two ports per adapter on the Gigabit Ethernet and 1000BASE-T Ethernet adapters, and one port per adapter on the 10 Gigabit Ethernet and 25 Gigabit Ethernet adapters. z/VM supports isolation of QDIO data connection communication on a shared OSA-Express7S port in support of multitier security zones. OSA/SF on the HMC is required to customize the OSA-Express7S modes. For additional information on the capabilities of this OSA Express feature, consult IBM Z Connectivity Handbook (https://www.redbooks.ibm.com/abstracts/sg245444.html).

Table 16. Device support: Server features and miscellaneous devices (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
OSA-Express7S 1.2	All	OSA-Express7S 1.2 GbE, 10GbE, 25GbE, and 1000Base-T are supported on IBM z16 family servers. OSA-Express7S 1.2 GbE, 10GbE, and 25GbE are supported on IBM z17 family servers. Must be dedicated to a virtual machine as a supported device. z/VM supports two ports per adapter on the Gigabit Ethernet and 1000Base-T Ethernet adapters, and one port per adapter on the 10 Gigabit Ethernet and 25 Gigabit Ethernet adapters. z/VM supports isolation of QDIO data connection communication on a shared OSA-Express7S 1.2 port in support of multitier security zones. OSA/SF on the HMC is required to customize the OSA-Express7S 1.2 modes. For additional information on the capabilities of this OSA Express feature, consult IBM Z Connectivity Handbook (https://www.redbooks.ibm.com/abstracts/sg245444.html).
Regional Crypto Enablement (RCE)	All	Supported on IBM z14 family, excluding LinuxONE.
Spyre Accelerator Adapter	All	Supported on IBM z17 family servers. Must be dedicated to a virtual machine as a supported device.
zEDC Express	7.3	Supported on IBM z14 family. Must be dedicated to a virtual machine as a supported device.
zHyperLink Express	All	Dynamic I/O support only. Not supported on LinuxONE.
10GbE RoCE Express	All	Supported on IBM z14 family and z15 family. Must be dedicated to a virtual machine as a supported device.
10GbE RoCE Express2	All	Supported on IBM z14 family, IBM z15 family, and IBM z16 family. Must be dedicated to a virtual machine as a supported device.
10GbE RoCE Express2.1	All	Supported on IBM z15 family and IBM z16 family. Must be dedicated to a virtual machine as a supported device.

Table 16. Device support: Server features and miscellaneous devices (continued)

Note: Current z/VM releases are 7.4 and 7.3.

Device	Current z/VM release support	Support notes
25GbE RoCE Express2	All	Supported on IBM z14 family, IBM z15 family, and IBM z16 family. Must be dedicated to a virtual machine as a supported device.
25GbE RoCE Express2.1	All	Supported on IBM z15 family and IBM z16 family. Must be dedicated to a virtual machine as a supported device.
10GbE RoCE Express3	All	Supported on IBM z16 family. Must be dedicated to a virtual machine as a supported device.
25GbE RoCE Express3	All	Supported on IBM z16 family. Must be dedicated to a virtual machine as a supported device.
3088	All	Must be dedicated to a virtual machine as a supported device.
3088 Model 61 PSCA Card (common link access to workstations)	All	
3174 Model 12L, 22L	All	

Appendix D. z/VM system limits

Minimum requirements and maximum limits for some system resources are listed.

Supported servers and processors

The following table lists servers and processors that z/VM supports.

Table 17. Servers and processors that z/VM supports

Resource	z/VM 7.4	z/VM 7.3
Supported servers		
IBM Z and LinuxONE servers supported	z15 T01 and T02, LinuxONE LT1 and LT2 and newer	z14, z14R1, LinuxONE Emperor II and Rockhopper II and newer
Supporting resources: 1. Exploiting a z/VM Single System Image (SSI) environment may help to alleviate constraints for many of these limits. 2. Some of the limits defined within this table can be determined programmatically from z/VM CP Environment Variables. See https://www.vm.ibm.com/newfunction/varlist.html for additional details.		
Processors (maximum limits)		
Logical Processors SMT Disabled (SMT-0)	80 on z15 and newer	80 on z14 and newer
Logical Processors SMT Enabled 1 thread per core (SMT-1) See processor limits note “1” on page 111.	40 on z15 and newer	40 on z14 and newer
Logical Processors (SMT Enabled 2 threads per core (SMT-2, 2 logical processors on each IFL code)	40 on z15 and newer	40 on z14 and newer
Virtual CPUs in a single virtual machine See processor limits note “2” on page 111.	64	64
Processor limits notes: 1. Once SMT is enabled the CPU address for the second thread needs to be preserved. This results in only half the 'processors' limit to be available. The maximum SMT enabled processor value assumes an all-IFL configuration. z/VM will not activate a second thread (logical processor) for non-IFL cores, so the limit is the maximum shown minus the number of non-IFL cores defined for the z/VM logical partition. 2. $N_{Virtual} > N_{Logical}$ is usually not practical.		

Maximum memory limits and minimum memory requirements

The following table lists maximum memory limits and minimum memory requirements to install and run z/VM.

Table 18. z/VM memory limits: Maximum limits and minimums to install and run z/VM

Resource	z/VM 7.4	z/VM 7.3
Memory[1]: Maximum limits and minimum requirements to install and run z/VM		
Maximum real Memory See memory limits note "2" on page 112.	4 TB	4 TB
Maximum virtual memory in a single virtual machine See memory limits notes "3" on page 112, "4" on page 112, and "6" on page 112.	2 TB See memory limits note "6" on page 112.	2 TB with the PTF for APAR VM66673 See memory limits note "6" on page 112.
Minimum real memory size of the LPAR for installing z/VM as a first-level system	768 MB	768 MB
Minimum real memory size to IPL z/VM as a first-level system	512 MB	512 MB
Minimum virtual memory to install z/VM as a second-level system	128 MB	128 MB
Minimum virtual memory to IPL z/VM as a second-level system See memory limits note "5" on page 112.	128 MB	128 MB

Maximum memory limits and minimum memory requirements to install and run z/VM: Notes:

1. z/VM publications use the term *storage*.
2. Virtual to real memory ratio (practical) is about 2:1 or 3:1.

   With a definition for "Virtual to real memory" of total virtual machine size of started virtual machines to real memory configured to z/VM.

   Practical over commitment is dependent on factors such as Active:Idle virtual machines, Workload/Service Level Agreement sensitivity to delays, performance of paging subsystem (e.g. flash, HyperPAV, channels, etc.), accuracy of sizing of the virtual machines, and exploitation of memory saving/exploitation capabilities (e.g. CMM, DIM).
3. Practical limit can be gated by performance of Dumping a VM system, Live Guest Relocation requirements, and production level performance requirements.
4. Due to the number of supporting DAT tables needed, the limit of the sum of all virtual machines' instantiated pages is 64T.
5. If the second-level system is IPLed from an FCP SCSI LUN, the minimum virtual memory required is dependent on the model of the processor on which the z/VM system is running. To ensure success on all processor models, define at least 768 MB of virtual storage.
6. 2TB virtual storage is supported with base of 7.4 or with 7.3 APAR VM66673 under a set of restrictions. Details about restrictions can be found at z/VM Memory Management (https://www.vm.ibm.com/memman/gt1guest.html).

Dynamic memory management limits

The following table lists dynamic memory management limits.

Table 19. z/VM memory limits: Dynamic memory management	
Memory: Dynamic memory management limits	
Resource	**z/VM 7.4, z/VM 7.3**
Minimum memory defined as Permanent Storage in order to use Dynamic Memory	4 GB
Maximum percentage of memory that can be defined as Reconfigurable memory with Dynamic Memory Management See memory limits note “1” on page 113.	50%
Dynamic memory management limits notes: 1. A minimum hardware bundle level is required to avoid a possible downgrade stall; refer to: https://www.vm.ibm.com/memman/dmd.html.	

Other z/VM memory limits

The following table lists other z/VM memory limits.

Table 20. z/VM memory limits: Other limits	
Resource	**z/VM 7.4, z/VM 7.3**
z/VM memory limits: Other limits (maximums)	
System Execution Space (SXS), maximum	2 GB
DCSS – Individual Segments, maximum See memory limits note “1” on page 113.	Up to 2047 MB
Minidisk Cache (MDC), maximum See memory limits notes “2” on page 113 and “3” on page 113.	8 GB
z/VM memory limits: Other limits. Notes: 1. Segments must end prior to one 4KB page below 512 GB. 2. The recommended limit is 2 GB. 3. Recommend fixing MDC size rather than letting arbiter change it dynamically.	

Paging limits

The following table lists paging limits.

Table 21. z/VM paging limits	
Resource	**z/VM 7.4, z/VM 7.3**
Paging space (maximum limits)	
CP Owned Volumes	255
Maximum paging space design limits ECKD (3390)	202 TB

Table 21. z/VM paging limits (continued)	
Resource	**z/VM 7.4, z/VM 7.3**
Maximum paging space design limits EDEV (SCSI)	15.9 TB

I/O limits

The following table lists I/O limits.

Table 22. I/O limits	
Resource	**z/VM 7.4 and 7.3**
I/O devices (maximum limits)	
Number of subchannels (device numbers) in a partition	65,536
Number of devices per virtual machine	24576 (24 K)
I/O device limits note: GDPS environments can have secondary DASD devices defined in an alternate subchannel set with the Multiple Subchannel Set Support.	
Concurrency	ECKD without PAV or HyperPAV: 1 ECKD with PAV or HyperPAV: 8
I/O disk sizes (maximums)	
ECKD 3390 - CMS	~45 GB / 65,520 cylinders (practical 22 GB) See I/O disk size limits note “2” on page 114
ECKD 3390 - Minidisk	~812 GB / 1,182,006 cylinders
ECKD 3390 - Dedicated	~812 GB / 1,182,006 cylinders
ECKD 3390 – CP Use	~812 GB / 1,182,006 cylinders ~45 GB nonpaging
SCSI EDEVICE - CMS	381 GB (practical 22 GB) See I/O disk size limits note “2” on page 114.
SCSI EDEVICE - Minidisk	1023 GB See I/O disk size limits note “1” on page 114.
CSI EDEVICE - Dedicated	1023 GB See I/O disk size limits note “1” on page 114.
SCSI EDEVICE – CP Use	64 GB See I/O disk size limits note “3” on page 114.
I/O disk size limits notes: 1. Exact value is 1024 GB minus 4 KB. 2. Due to file system structure under 16 MB, unless there are very few files. 3. CP can use, but PAGE, SPOL, DRCT must be below 64 GB on the volume.	

Table 22. I/O limits (continued)	
Resource	**z/VM 7.4 and 7.3**
Other I/O limits (maximums)	
Virtual Disk in Storage (VDISK)	2 GB See other I/O limits note "1" on page 115.
Number of OSA devices for different virtual switch configurations	Local VSWITCH: 1 active device and up to 2 backup devices. Local VSWITCH in an exclusive port group: 8 port group devices and up to 3 backup devices Global VSWITCH in a shared port group: 8 port group devices
Multi-VSwitch link aggregation limits	Members in an Inter-Vswitch Link (IVL) domain: 16 Number of virtual switches across an IVL domain: 64 Global virtual switches in the same shared port group: 4
Real HiperSockets VLAN IDs	4094
Other I/O limits note: 1. Minus eight 512-byte blocks. Total VDISK z/VM design is 1 TB.	

Other limits

The following table lists other limits.

Table 23. Other limits	
Resource	**z/VM 7.4, z/VM 7.3**
Other limits (maximums)	
Number of spool files per z/VM systems	1.6 Million
Number of spool files per Virtual Machine	9999 (non-SSI) 2499 (4-member SSI) 1249 (8-member SSI)
CMS Files	Maximum Records is 2,147,483,647 (2^{31}–1) records, each of which consist of from one to 2^{31}–1 bytes of data A record in a file with variable-length records is further restricted to 65,535 bytes of data
CP-Owned slots	255
ISFC Links between pair of systems Note: No limit on total number of ISFC links	16
Distributed IUCV maximum message size	1 GB

Table 23. Other limits (continued)	
Resource	**z/VM 7.4, z/VM 7.3**
Alternate Operators	8
Password length	8 characters 100 characters with RACF
1000 System Environment Variables See other limits note “1” on page 116.	Up to 63 character named Up to 255 character values
HyperPAV aliases	254 per pool 160,000 pools per system
Diagnose x’00’ information	5 levels of information
Other limits notes: 1. For z/VM 7.4, the actual number of z/VM System Environment Variables available is 1000 minus those defined as z/VM 7.4, 7.3, and 7.2 CP New Function environment variables and 7.4 z/VM service environment variables. For z/VM 7.3, the actual number of z/VM System Environment Variables available is 1000 minus those defined as z/VM 7.3 and 7.2 CP New Function environment variables. For a complete list of z/VM CP New Function environment variables, see IBM: z/VM New Function Variable List (https://www.vm.ibm.com/newfunction/varlist.html). For a complete list of z/VM service environment variables, see z/VM Service Environment Variable List (https://www.ibm.com/vm/service/zvmsrvev.html).	

SSI cluster distance limits

The following table lists SSI cluster distance limits.

Table 24. SSI cluster distance limits for z/VM	
Resource	**z/VM 7.4, z/VM 7.3**
SSI cluster distance limits (maximums)	
DASD and FICON CTC	100 km with repeater technology
OSA to Switches	10 km with repeater technology
Relocation of virtual machines with a virtual switch defined	must be defined in the same LAN segment (s)

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