

*z/VM*  
*built on IBM Virtualization Technology*



# General Information

*Version 5 Release 1*



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# General Information

*Version 5 Release 1*

**Note:**

Before using this information and the product it supports, read the information in “Notices” on page 111.

**Third Edition (January 2005)**

This edition applies to version 5, release 1, modification 0 of IBM z/VM (product number 5741-A05) and to all subsequent releases and modifications until otherwise indicated in new editions.

This edition replaces GC24-6095-01.

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## About This Book

This book provides general information about IBM® z/VM®, Version 5 Release 1 (z/VM V5R1). It contains:

- An introduction to z/VM V5
- An explanation of z/VM V5's cost/performance benefits
- An overview of what is new or changed in z/VM V5R1
- Hardware and program (software) requirements and other technical information about z/VM V5R1
- Descriptions of the z/VM base facilities and optional features
- A guide to the z/VM product documentation
- Lists of the IBM servers, guest operating systems, and devices supported by current z/VM releases

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## Who Should Read This Book

This book is intended for anyone who wants a general overview of z/VM V5R1 and its major facilities. It also provides information for those who need to evaluate the capabilities of z/VM V5R1 and determine the resources necessary to install and run it.

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## Where to Find More Information

You can obtain more information about z/VM from the books listed in the z/VM library guide, which begins on page 65. The library guide includes an abstract of each book.

**Note:** This edition has been published for the announcement of programming enhancements to z/VM V5R1. Some sources of additional information identified in this book might not be available until the general availability of those enhancements.

### Links to Other Online Books

If you are viewing the Adobe Portable Document Format (PDF) version of this book, it may contain links to other books. A link to another book is based on the name of the requested PDF file. The name of the PDF file for an IBM book is unique and identifies both the book and the edition. The book links provided in this book are for the editions (PDF names) that were current when the PDF file for this book was generated. However, newer editions of some books (with different PDF names) may exist. A link from this book to another book works only when a PDF file with the requested name resides in the same directory as this book.

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## Summary of Changes

This book contains terminology, maintenance, and editorial changes. Technical changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

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### **GC24-6095-02, z/VM Version 5 Release 1, Additional Updated Edition**

This edition includes information about additional z/VM V5R1 support and programming enhancements that were announced or provided after the publication of the previous edition of this book. Programming enhancements may be provided through z/VM service by program temporary fixes (PTFs) for authorized program analysis reports (APARs). For more information, see Chapter 3, “What Is New or Changed in z/VM V5R1,” on page 11.

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### **GC24-6095-01, z/VM Version 5 Release 1, Updated Edition**

This edition includes information about support added or announced after the announcement of z/VM V5R1 and programming enhancements provided after the general availability of z/VM V5R1.



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## Chapter 1. Introducing z/VM V5

z/VM V5 is an operating system for IBM *@server*<sup>®</sup> zSeries<sup>®</sup> or equivalent servers that support the 64-bit IBM z/Architecture<sup>™</sup>. z/VM provides a highly flexible test and production environment for enterprises deploying the latest on demand business solutions. The z/VM implementation of IBM virtualization technology provides the capability to run other full-function operating systems, such as Linux<sup>®</sup> on zSeries and z/OS<sup>®</sup>, under z/VM as “guest” systems. z/VM supports IBM z/Architecture (64-bit) guests and IBM Enterprise Systems Architecture/390<sup>®</sup> (31-bit) guests.

**Note:** z/VM is the successor to IBM’s VM/ESA<sup>®</sup> operating system. Some products or publications that support z/VM may continue to use VM/ESA in their names.

The z/VM base product includes the following facilities:

- Control Program (CP)
- Conversational Monitor System (CMS)
- Transmission Control Protocol/Internet Protocol (TCP/IP) for z/VM
- Advanced Program-to-Program Communication/Virtual Machine (APPC/VM) Virtual Telecommunications Access Method (VTAM<sup>®</sup>) Support (AVS)
- Dump Viewing Facility
- Group Control System (GCS)
- Hardware Configuration Definition (HCD) and Hardware Configuration Manager (HCM) for z/VM
- Language Environment<sup>®</sup>
- Open Systems Adapter Support Facility (OSA/SF)
- Restructured Extended Executor/Virtual Machine (REXX/VM)
- Transparent Services Access Facility (TSAF)
- Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E)

For more information about these facilities, see Chapter 5, “z/VM Base Facilities,” on page 43.

z/VM also offers the following optional features:

- Data Facility Storage Management Subsystem for VM (DFSMS/VM<sup>®</sup>)
- Directory Maintenance Facility (DirMaint<sup>™</sup>)
- Performance Toolkit for VM<sup>™</sup>
- Resource Access Control Facility (RACF<sup>®</sup>) for z/VM

For more information about these features, see Chapter 6, “z/VM Optional Features,” on page 61.

---

## z/VM Supports Open Environments

By supporting a wide range of public and industry standards, protocols, and interfaces, z/VM provides a foundation for open enterprise network computing.

### Network Computing

z/VM supports today’s computing environments by providing a natural infrastructure for network computing, enabling you to participate in multisystem environments. You can connect your z/VM system and its data to a corporate intranet or serve your

## Introduction

data to customers on the Internet and the World Wide Web. Through the use of shareware or IBM Business Partner Web servers and Web-related products on z/VM, information stored on z/VM can be presented to your organization and your customers using the latest Web technology.

z/VM networking support includes:

- **TCP/IP for z/VM.** TCP/IP for z/VM, which is included with z/VM, provides common protocols and applications that enable access to data from heterogeneous system platforms.
- **MQSeries® Client for VM/ESA.** IBM WebSphere® MQ (formerly MQSeries) enables applications on different systems and architectures to work together. MQSeries Client, which is an additional program product that runs on CMS, enables client or server applications in the network to connect to applications on z/VM that have implemented the WebSphere MQ communication protocol.

**Note:** Because MQSeries Client is not a full-function queue manager, use of the WebSphere MQ application programming interfaces on z/VM requires the deployment of a WebSphere MQ server in the network.

## POSIX and XPG Support

z/VM supports selected standards of the Institute of Electrical and Electronics Engineers (IEEE) portable operating system interface for computer environments (POSIX) and the X/OPEN portability guide (XPG). z/VM provides a set of UNIX®-based programming interfaces and a shell environment in a collection of application development services called OpenExtensions™. These services allow you to port applications from UNIX and other POSIX-compliant platforms to z/VM. They also allow you to develop POSIX-compliant applications on z/VM and port them to other POSIX-compliant platforms.

## Heterogeneous Connectivity

z/VM provides a wide range of networking and connectivity options and adheres to many of the industry standards, enabling communications across distributed heterogeneous environments. Examples include:

- Binary synchronous communications (BSC)
- Ethernet
- Fiber distributed data interface (FDDI)
- Fibre Channel Protocol (FCP)
- File transfer protocol (FTP)
- IEEE Virtual Local Area Network (VLAN)
- Internet Protocol (IP)
- Network file system (NFS)
- Simple mail transfer protocol (SMTP)
- Systems Network Architecture (SNA)
- Transmission Control Protocol (TCP)
- Token-ring
- User datagram protocol (UDP)
- X.25
- X.400 mail exchange protocol
- X-Windows

Network management support is provided through support of the simple network management protocol (SNMP), which is part of TCP/IP, and through IBM-defined interfaces supported in Virtual Machine Remote Spooling Communications Subsystem Networking (RSCS) and NetView®.

**Note:** For your convenience, the IBM RSCS licensed program is shipped with z/VM and installed in a disabled state. To enable the program, all you need to do is contact IBM to establish a license.

## Enterprise Computing

z/VM supports a wide range of enterprise computing alternatives, including a relational database and a shared file system:

- **IBM Database 2™ Server for VSE & VM (DB2® Server for VM).** The DB2 Server for VM licensed program provides local relational database support, as well as distributed access and update of distributed relational data on various platforms using IBM's Distributed Relational Database Architecture™ (DRDA®).
- **CMS shared file system (SFS).** SFS capability, which is included with z/VM, allows data sharing among users and across multiple z/VM system images or servers.

---

## z/VM Virtualization Technology Provides Guest Support

z/VM presents a unique approach to computer operating systems. It provides each end user with an individual working environment known as a *virtual machine*. The virtual machine simulates the existence of a dedicated real machine, including server functions, storage, and input/output (I/O) resources.

But virtual machines support much more than just end users. Application programs and operating systems can run in virtual machines. z/VM can support multiple z/Architecture and Enterprise Systems Architecture/390 (ESA/390) operating systems. For example, you can run multiple Linux and z/OS images on the same z/VM system that is supporting z/VM applications and end users. As a result, application development, testing, and production environments can share a single physical computer.

For a list of the operating systems supported as guests, see Appendix B, “IBM Operating Systems Supported as Guests of z/VM,” on page 91.

The virtual machine capability of z/VM allows you to:

- **Run multiple Linux images.** In an environment where multiple Linux images are required, many Linux images can be set up to run concurrently and independently on a single z/VM image.
- **Test programs that can cause abnormal termination of real machine operations and, at the same time, process production work.** The isolation that is provided for a virtual machine enables system-oriented programs and teleprocessing applications, for example, to be tested on the virtual machine while production work is in progress, because this testing cannot cause abnormal termination of the real machine.
- **Test a new operating system release.** A new release of an operating system can be generated and tested at the same time that the existing release is performing production work. This enables the new release to be installed and put into production more quickly. The ability to operate multiple operating systems concurrently under z/VM may enable an installation to continue running programs

## Introduction

that operate only under a back-level release (programs that are release-sensitive and uneconomical to convert, for example) concurrently with the most current release.

- **Test a new operating system.** The existing operating system can be used to process production work concurrently with the generation and testing of a new operating system. Experience with the new system can be obtained before it is used on a production basis, without dedicating the real machine to this function.
- **Perform operating system maintenance concurrently with production work.** The installation and testing of program temporary fixes (PTFs) for an operating system can be done at the same time normal production operations are in progress.
- **Provide backup facilities for the primary operating system.** A generated z/VM system is not model-dependent and can operate on various server models as long as the minimum hardware requirements are present. This enables a smaller server model that has less real storage, fewer channels, fewer direct access devices, and fewer unit record devices than a larger server model to provide backup for the larger model (normally at a reduced level of performance).
- **Perform operator training concurrently with production work processing.** The real machine does not have to be dedicated to training additional or new operators or to providing initial training when a new operating system is installed. Operator errors cannot cause termination of real machine operations.
- **Simulate new system configurations before the installation of additional channels and I/O devices.** The relative load on channels and I/O devices can be determined using the simulated I/O configuration rather than the real I/O configuration. Experience with generating and operating an I/O configuration for multiple guest operating systems can be obtained using one real machine.
- **Test customer-written system exits.** Customer-written system exits can be tested without disrupting production work.

---

## z/VM Provides Host-Based Services for the Workstation Environment

Because z/VM is built on a client/server-like model, it can function both as a mainframe server to LAN users and as a client to a LAN server or another mainframe. For example, z/VM supports the following products in a client/server environment:

- **IBM Tivoli® Storage Manager.** Tivoli Storage Manager (TSM) is a client/server tool that enables backup, archiving, and restoration of workstation files, utilizing the host z/VM system and direct access storage devices (DASD). Tivoli Storage Manager moves the responsibility for storage management to z/VM, while providing client applications for a number of workstation-based environments, such as Microsoft® Windows®, Linux, and Apple Macintosh.
- **IBM Tivoli Storage Manager Extended Edition.** Tivoli Storage Manager Extended Edition delivers an integrated data-protection solution for large enterprises. It expands on the data backup and restore, and managed data archive and retrieve capabilities of the base Storage Manager by adding disaster planning capability and support for large tape libraries.

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## z/VM Supports Application Development and Deployment

z/VM supports a number of programming languages and environments, including:

- APL2®
- Assembler
- C

- C++
- COBOL
- FORTRAN
- Language Environment
- MQSeries Client (WebSphere MQ)
- PASCAL
- PL/I
- REXX
- Systems Application Architecture<sup>®</sup> (SAA<sup>®</sup>) common programming interface (CPI)
- VisualAge<sup>®</sup> Generator

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:

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

Special APIs and other facilities are available to CMS applications, such as:

- Enterprise Systems Architecture/Extended Configuration (ESA/XC) support
- CMS Pipelines
- Callable services library (CSL)
- CMS multitasking services
- OpenExtensions (POSIX interfaces and shell)
- Program Management Binder
- Systems management APIs
- Reusable Server Kernel
- Assembler macros and functions
- OS/MVS simulation
- DOS/VSE support

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 may 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 Provides a Rich Set of User Services**

z/VM provides end user services in several important environments:

- Decision support, problem solving, expert systems
- Document creation, editing, and publishing
- Image storage and retrieval
- Graphics development and manipulation
- Communications and document exchange with users on other systems
- Computer integrated manufacturing
- Engineering/scientific computing
- Application development
- Application testing
- Communications services
- Accessing other systems
- System management
- Network management
- System testing

---

### **z/VM Provides Proven System Integrity, Security, and Reliability**

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

- Integrity and security:
  - z/VM supports guest use of the cryptographic facilities provided by supported IBM servers.
  - IBM will correct any integrity exposures introduced by unauthorized programs into the system.
  - Kerberos authentication and Secure Sockets Layer (SSL) support are provided through TCP/IP for z/VM.
  - Integrated access control and authentication services may be augmented with the addition of the RACF for z/VM feature or other external security managers.

Also see “Integrity and Security” on page 38.

- 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 SystemView<sup>®</sup> Host Management Facilities/VM can be added. Both the Programmable Operator and Host Management Facilities/VM can interact with NetView on z/VM, which in turn can interact with NetView on z/OS.
  - 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.

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## **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

## Introduction

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## Chapter 2. What z/VM V5 Can Do for You

z/VM V5 can help create an infrastructure for on demand business environments. z/VM V5 extends the strength of the zSeries environment as an ideal platform for consolidating select UNIX, Windows, and Linux workloads on a single physical zSeries server. This can allow you to run tens to hundreds of Linux servers with the potential to support workloads, achieve productivity gains, and lower IT costs. z/VM supports Linux on the mainframe and can enable Linux servers to share hardware resources and use internal high-speed communication within the zSeries environment. You can add capacity to existing zSeries systems for hosting Linux-on-z/VM workloads by configuring your server with Integrated Facility for Linux (IFL) engines.

z/VM V5 has a new engine-based Value Unit pricing model, which replaces the per-engine pricing model applicable to z/VM V4 and V3. Engine-based Value Unit pricing is designed to:

- Help reduce the expense of incremental growth; that is, the price per-engine for z/VM V5 becomes less as more engines are added (purchased).
- Make it more affordable for you to add z/VM to an existing standard engine environment.

This can help enable you to use z/VM to host workloads that cannot run on IFL engines, such as z/OS, z/OS.e, VSE/ESA, or TPF, or to consolidate existing VM/ESA or z/VM V3 and V4 workloads onto a single, larger zSeries server.

As the successor product to VM/ESA, z/VM V3, and z/VM V4, z/VM V5 provides additional support and exploitation opportunities for clients who have built enterprise-wide automation and infrastructure enhancements on the VM platform in support of their applications, database systems, and on demand business solutions.

z/VM V5 allows you to put the power of zSeries server partitioning and z/VM virtualization technology to work for you to help realize the benefits of workload isolation and resource sharing, which include:

- Reliability, availability, and serviceability of IBM zSeries servers
- Flexibility to logically partition zSeries processors to support up to 30 logical partitions (LPARs)
- Ability to use z/VM to further partition each LPAR into many virtual servers
- Virtualization of processor, communication, memory, storage, I/O, and networking resources
- Ability to significantly enhance the utilization of system resources
- Dynamic allocation of resources
- Performance of high-speed communications among LPARs and guests with HiperSockets
- Availability of advanced systems management, administration, and accounting tools

z/VM V5 is intended to address the following situations:

- **Running more Linux server images on a single zSeries server.** Considerably more images than are currently supported by the LPAR mode of operation (30 on the z990 and z890, and 15 on the z900 and z800) can be achieved with z/VM guest support. These Linux on zSeries server images can be deployed on standard engines (CPs) or IFL engines with z/VM V5. Running multiple Linux on

## Benefits

zSeries server images on an IFL-configured z/VM system may not increase the IBM software charges of your existing zSeries environment. You can add z/VM V5 running on IFL engines to your existing z/OS, z/OS.e, z/VM, TPF, VSE/ESA, or Linux on zSeries environment without necessarily increasing software costs on the standard engines (CPs).

- **Moving select Linux, Windows, and UNIX workloads to a single zSeries server while maintaining distinct server images and current LAN topology.** This ability can help reduce systems management complexity. Because the number of real hardware servers and associated LANs is reduced, cost savings may be realized by managing large server farms deployed on virtual servers instead of using multiple hardware servers. Deploying Linux workloads on z/VM V5 is particularly attractive if they interact with applications or data located on the same zSeries server.
- **Enhanced virtual networking.** This provides external connectivity for Guest LANs through an OSA-Express adapter without a z/VM or Linux router virtual machine.
- **Executing 64-bit operating systems running on a zSeries server.** This helps provide real memory constraint relief by running z/VM in 64-bit mode on a zSeries server. This constraint relief is provided for ESA/390 guest operating systems. Running TPF or large numbers of OS/390, VME/ESA, or Linux server images may benefit from z/VM 64-bit support.
- **Migrating from VM/ESA to z/VM V5.** This helps enable:
  - More memory to cache CMS minidisks by exploiting memory above 2 GB for minidisk cache
  - Connectivity (TCP/IP) enhancements and additional device support
  - Added security with SSL-protected TCP/IP network traffic, such as Telnet sessions and Web transactions
- **Migrating to the new version or release of a guest operating system using z/VM V5.** This can provide added flexibility for migration, production, and testing. For example, z/VM V5 can help you migrate from OS/390 to z/OS or z/OS.e.
- **Enhanced guest Parallel Sysplex support in z/VM with the exploitation of IBM z/Architecture.** This can enable addressability of larger amounts of real and virtual memory, allowing the development and testing of 64-bit Parallel Sysplex applications in a guest environment.

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## Chapter 3. What Is New or Changed in z/VM V5R1

This chapter provides an overview of the new functions, enhancements, and other changes included in z/VM V5R1.

**Note:** Some enhancements described in this chapter identify support added or announced after the announcement of z/VM V5R1 and programming enhancements provided after the general availability of z/VM V5R1. Programming enhancements may be provided through z/VM service by program temporary fixes (PTFs) for authorized program analysis reports (APARs).

The product changes are described under the following topics:

- “Virtualization Technology and Guest Support”
- “Network Virtualization and Security” on page 13
- “Technology Exploitation” on page 15
- “Systems Management Improvements” on page 20
- “Application Support” on page 21
- “Packaging Modifications and Withdrawal of Functions or Support” on page 22

This chapter also includes a “Statement of Direction” on page 24.

For descriptions of the changes included in previous z/VM releases, see the *z/VM: Migration Guide*.

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### Virtualization Technology and Guest Support

This section describes extensions to z/VM virtualization technology in support of Linux, z/OS, and other guests.

### Small Computer System Interface (SCSI) Fibre Channel Protocol (FCP) Disk Support

z/VM V5R1 supports SCSI FCP disk logical units (SCSI disks) for both system and guest use. SCSI disks supported are those within an IBM TotalStorage<sup>®</sup> Enterprise Storage Server<sup>®</sup> (ESS) when it is connected to a Fibre-Channel fabric by zSeries FCP channels.

SCSI disks can be used directly by a guest operating system when an FCP subchannel is dedicated to the guest. Such a guest must provide its own SCSI device support. Linux on zSeries is designed to be one such guest.

SCSI disks can also be used as emulated 9336 Model 20 fixed-block-architecture (FBA) disks. z/VM CP and CMS rely almost exclusively on this emulated-FBA support for their SCSI use. Specifically, this use includes system paging, spooling, directory services, minidisks, and all other system functions and programming services that can use FBA disks. Guests that support FBA disks (such as CMS, GCS, RSCS, and VSE) also can use SCSI disks through the emulated-FBA support, without requiring their own SCSI support.

z/VM's SCSI support allows a Linux server farm to be deployed on z/VM in a configuration that includes only SCSI disks. Extended count key data (ECKD<sup>™</sup>) disks are no longer required. Installation of z/VM from DVD to a SCSI disk, IPL from

## New or Changed

a SCSI disk using Stand-Alone Program Loader (SAPL), and z/VM system dumps to a SCSI disk are supported. DASD Dump/Restore (DDR) services using SCSI disks are supported when DDR is running under CMS.

z/VM supports an individual emulated FBA disk up to 381 GB in size. However, directory, paging, and spooling allocations must reside within the first 64 GB of a CP-formatted volume. Other kinds of CP allocations may be defined beyond the first 64 GB.

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

## Installation of z/VM from DVD

z/VM V5R1 includes the capability to install z/VM from a DVD to an ESS SCSI disk emulated as an FBA device or to a 3390 DASD. Installing from a DVD can significantly reduce the required installation media and allows you to install to a zSeries server using only SCSI disks. This is expected to be most beneficial in a z/VM environment with Linux on zSeries guests and without traditional install devices such as IBM TotalStorage tape drives attached to the IBM zSeries server. This capability requires the Hardware Management Console, Version 1.8 or later.

For more information, see the *z/VM: Guide for Automated Installation and Service*.

## Coordinated Continuous Availability and Disaster Recovery for Linux on zSeries Guests

z/VM V5R1 provides a new HyperSwap™ function so that the virtual devices associated with one real disk can be swapped transparently to another. HyperSwap can be used to switch to secondary disk storage subsystems mirrored by Peer-to-Peer Remote Copy (PPRC). It may also be helpful in data migration scenarios to allow applications to use new disk volumes.

Geographically Dispersed Parallel Sysplex™ (GDPS®) 3.1 plans to exploit the new z/VM HyperSwap function to provide a coordinated near-continuous availability and disaster recovery solution for distributed applications, such as WebSphere, that span z/OS images running natively and Linux on zSeries guests running under z/VM. This innovative disaster recovery solution requires GDPS, IBM Tivoli System Automation for Linux, Linux on zSeries, and z/VM V5R1 to help anticipate and rapidly respond to business objectives and technical requirements while maintaining high system availability. This solution may be especially valuable for customers who share data and storage subsystems between z/OS and Linux on zSeries.

To cover planned and unplanned outages, GDPS 3.1 is planning to provide the following recovery actions:

- In-place re-IPL of failing operating system images
- Site takeover/failover of a complete production site
- Coordinated planned and unplanned HyperSwap of storage subsystems transparently to the operating system images and applications using the storage

For more information about z/VM support, see the *z/VM: CP Commands and Utilities Reference*.

## Dynamic Virtual Machine Timeout

A new programming service is provided by an emulated DIAGNOSE instruction that helps enable a guest operating system to specify an action to be taken by CP when

the guest becomes unresponsive. The DIAGNOSE instruction also allows each guest to define what “unresponsive” means for itself. A time interval and action are specified by the guest. If the guest fails to reissue the DIAGNOSE instruction within the specified time interval, CP performs the action. The guest may define the action as any set of CP commands, although it is envisioned that this function will be used to terminate the virtual machine in which the guest is running if it becomes unresponsive. This can help ensure that a malfunctioning guest would no longer have access to shared system resources and would relinquish system resources to other guests.

For more information, see *z/VM: CP Programming Services*.

## New Publication for Deploying Linux on zSeries with z/VM

*z/VM: Getting Started with Linux on zSeries* describes z/VM basics and how to configure and use z/VM functions and facilities to create and manage Linux servers running on zSeries processors. The publication is designed to help systems personnel (system programmers, administrators, and operators) with limited knowledge of z/VM to deploy Linux servers on z/VM more quickly and more easily. The publication provides some requirements and guidelines for z/VM installation, but for the most part assumes that you have installed z/VM and are ready to deploy Linux servers in z/VM virtual machines. Specific topics covered include:

- Configuring, administering, and servicing a z/VM system
- Configuring TCP/IP for z/VM
- Creating and cloning Linux virtual machines
- Setting up basic system automation
- Monitoring performance and capacity

## FCP Logical Unit Numbers (LUN) Access Control by z/VM with Linux on zSeries Guests

With the PTF for **APAR VM63328**, z/VM V5R1 supports LUN access control for SCSI FCP disks connected to a FICON Express on a z890 or z990.

The LUN access control function of zSeries FCP channels is expected to provide added security for SCSI devices connected to a SAN. For a logical partition running z/VM V5R1, you can specify separate permissions for the z/VM system itself (when z/VM is using SCSI disks for system operations) and for each Linux on zSeries guest. In addition, if you run a second-level z/VM V5R1 system, you can specify separate permissions for that system and for each of its Linux on zSeries guests.

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

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## Network Virtualization and Security

This section describes enhancements to z/VM network virtualization and security.

### Enhanced Virtual Switch Support

The virtual Internet Protocol (IP) switch (Virtual Switch), introduced in z/VM V4R4, was designed to improve connectivity to a physical LAN for hosts coupled to a Guest LAN. It eliminated the need for a router by providing IP Version 4 (IPv4) connectivity to a physical LAN through an Open Systems Adapter-Express (OSA-Express).

## New or Changed

The Virtual Switch has been improved in z/VM V5R1 to provide enhanced failover support for less disruptive recovery for some common network failures, helping to ensure business continuity as well as infrastructure reliability and availability.

Enhancements include the ability to:

- Recover from the failure of a Virtual Switch's network connection by swapping from a failing OSA-Express device to a partially initialized backup device in less time, helping to reduce data loss
- Detect a stalled OSA-Express device associated with a Virtual Switch, with failover to a backup device
- Detect a non-functioning z/VM TCP/IP controller and failover to a backup controller
- Limit the number of SETIP requests sent to an OSA-Express to help prevent overload of the device

The Virtual Switch has also been enhanced to allow it to be configured as either VLAN-aware or VLAN-unaware. This configuration option defines the behavior of the Virtual Switch when operating in a LAN segment that may be virtually segmented by Virtual LANs (VLANs). The Virtual Switch's VLAN support is based on the IEEE 802.1Q specification and governs how the Virtual Switch processes Ethernet frames or IP packets that are VLAN tagged.

For more information about the Virtual Switch, see *z/VM: Connectivity*.

## Authorization Enhanced for Guest LANs and Virtual Switches

z/VM V5R1 enhances the authorization capabilities for z/VM Guest LANs and Virtual Switches by using the Resource Access Control Facility (RACF) or any equivalent external security manager (ESM) that supports this new authorization function. It is designed to provide ESM-centralized control of authorizations and VLAN assignment.

For more information, see:

- *z/VM: CP Planning and Administration*
- *Resource Access Control Facility: Security Administrator's Guide*

## Virtual Switch Exploitation of Layer 2 Support

With the PTFs for **APARs VM63538 and PQ98202**, z/VM V5R1 supports a new transport option for the Virtual Switch that defines the Virtual Switch as operating in Layer 2 mode. Layer 2 mode is supported for the OSA-Express and OSA-Express2.

In Layer 2 mode, each port on the Virtual Switch is referenced by its Media Access Control (MAC) address instead of by Internet Protocol (IP) address. Data is transported and delivered in Ethernet frames, providing the ability to handle protocol-independent traffic for both IP (IPv4 or IPv6) and non-IP (such as IPX, NetBIOS, or SNA). Coupled with the Layer 2 support in Linux on zSeries and the OSA-Express and OSA-Express2 support for the z890 and z990, Linux images deployed as guests of z/VM can operate more efficiently.

Port sharing on the OSA-Express or OSA-Express2 allows many stacks to share the same physical OSA NIC card, and provides a communication path between the LPAR and z/VM without having to send the traffic flow over the physical wire. There is a restriction with the Layer 2 support in that port sharing is supported only between Virtual Switches that are of the same transport type, such as Layer 2 with

Layer 2 and Layer 3 with Layer 3. A Layer 2 guest cannot communicate directly with a Layer 3 guest on the same adapter.

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

## Additional Device Connections for TCP/IP for z/VM

- TCP/IP stack utilization improvements for OSA-Express

For the z890 and z990 servers, the number of TCP/IP stacks that can share an OSA-Express adapter has increased from 84 to 160. This increase provides additional connections to enable more virtual machines to be connected to an external network. With the PTFs for **APARs VM63524 and PQ91421**, z/VM V5R1 supports this hardware enhancement.

- Improved virtualization supporting more TCP/IP stacks with OSA-Express2

With the new OSA-Express2 feature for the z890 and z990, the maximum number of connections (TCP/IP stacks) allowed can be increased up to 640. Support for 640 TCP/IP stacks is provided by the OSA-Express2 features (Gigabit Ethernet SX, Gigabit Ethernet LX, Gigabit Ethernet LR) running in QDIO mode only. With the PTFs for **APARs VM63524 and PQ91421**, z/VM V5R1 supports this new capability to allow additional connections to virtual machines, particularly Linux images.

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## Technology Exploitation

This section describes z/VM support and exploitation of new hardware, hardware facilities, and architectures.

**Note:** z/VM exploitation of hardware functions depends on hardware level and availability. For detailed information on hardware capabilities, requirements, and availability, refer to the appropriate hardware announcement materials.

## IBM @server zSeries 990 (z990) and zSeries 890 (z890)

z/VM V5R1 supports the enhanced z990 and the new z890. For complete information on the z890, see the appropriate hardware announcements. z/VM supports the following functions of the z990 and z890.

### Logical Channel Subsystems (LCSSs)

A new system structure was introduced on the z990 in May 2003, supporting a scalable channel subsystem – two logical channel subsystems (LCSSs). This scalability is being further expanded; you can now define four LCSSs on a single z990, continuing to facilitate “horizontal” growth. The z890 can support two LCSSs. The channel subsystem structure now offers the following:

- Four LCSSs (z990), two LCSSs (z890)
  - Each LCSS can have up to 256 channels defined.
  - Each LCSS can be configured with 1 to 15 logical partitions (LPARs).
    - Cannot exceed 30 LPARs per system.

**Note:** There is no change to the operating system maximums. One operating system image continues to support up to 256 Channel Path Identifiers (CHPIDs). z/VM V5R1 supports four LCSSs on a zSeries server with the capability to do dynamic-I/O configuration in any LCSS.

### Transparent Sharing of Additional Channel Resources Across LCSSs

When LCSSs were introduced, they were designed to provide transparent sharing of Internal Coupling Channels (ICs) and HiperSockets™ between separate LCSSs. This support has now been expanded to include the ICB-3, ICB-4, ISC-3, FICON™ Express, and OSA-Express features. They are now capable of being configured as Multiple Image Facility (MIF) spanning channels, allowing sharing of channel resources across LPARs.

Spanned channels can be shared among LPARs across LCSSs. ICB-3, ICB-4, ISC-3, FICON Express, and OSA-Express can be configured to multiple channel subsystems and are intended to be shared transparently by any or all of the configured LPARs without regard to the LCSS to which the LPAR is configured.

z/VM V5R1 supports all of the spanned channel types identified, and also supports internal spanned channels.

### OSA-Express Integrated Console Controller

With the new z890 and enhancements to the z990, IBM is introducing a new function for the OSA-Express 1000BASE-T Ethernet feature and a new Channel Path Identifier (CHPID) type, OSC. The new OSA-Express Integrated Console Controller (OSA-ICC) function supports TN3270E and non-SNA DFT 3270 emulation. Now, 3270 emulation for console session connections is integrated in the z990 and z890 through a port on the OSA-Express 1000BASE-T Ethernet feature. This can help eliminate the requirement for external console controllers (2074, 3174), which can help reduce cost and complexity while improving productivity by requiring fewer mainframe skills to operate an on demand system environment.

OSA-ICC support is available with the OSA-Express 1000BASE-T Ethernet feature, and can be configured on a port-by-port basis. A port on the 1000BASE-T Ethernet feature can be configured as an OSD, OSE, or OSC CHPID type. Use of the OSA-ICC and the OSC CHPID type is supported by z/VM V5R1.

For more information, see:

- *z/VM: CP Commands and Utilities Reference*
- *eServer zSeries: Open Systems Adapter-Express Integrated Console Controller User's Guide*

### Improvements to Capacity Upgrade on Demand

z/VM V5R1 supports the On/Off Capacity on Demand (On/OffCoD) and the Capacity Backup Upgrade (CBU) functions on IBM zSeries servers and includes functional enhancements that can allow z/VM to:

- Recognize changed processor configuration settings on a zSeries system to:
  - Report the change in configuration to the system operator
  - Report the change in configuration to guests that support configuration change notification
- Recognize changed processor capacity settings on zSeries systems to:
  - Report the change in capacity to guests that support capacity measurement for billing purposes
  - Report the capacity change in z/VM monitor and accounting data

## Up to 24 Processor Engines in a Single z/VM Image

z/VM supports up to 64 virtual processor engines in a single guest configuration. z/VM V5R1 can support customer growth by allowing up to 24 real processor engines in a single z/VM image on a z990. The specific workload will influence the efficiency with which a specific z/VM system can use larger numbers of engines. Generally, z/VM overhead is expected to be lower with fewer, more CPU-intensive guests than with many lightly loaded guests. Excessive overcommitment of storage could contribute to increased overhead as well.

## PCIX Cryptographic Coprocessor (PCIXCC)

z/VM V5R1 provides z/OS and Linux on zSeries guest support for the PCIXCC feature available with the IBM @server zSeries 990 (z990) and zSeries 890 (z890). z/VM support includes:

- Dedicated-queue support for clear-key and secure-key cryptographic functions for z/OS guests
- Shared-queue and dedicated-queue support for clear-key cryptographic functions for Linux on zSeries guests, with up to 256 dedicated queues

Support for the PCIXCC cryptographic feature may help protect your assets. The PCIXCC feature is designed to deliver improved performance for secure cryptographic functions compared with the PCI Cryptographic Coprocessor (PCICC) feature.

z/VM supports the PCI Cryptographic Accelerator (PCICA) feature on the IBM z990, z900, z890, and z800, as well as the PCICC feature on the IBM z900 and z800. z/VM's clear-key RSA support for a considerably large number of Linux on zSeries guests helps enable hardware Secure Socket Layer (SSL) acceleration.

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

## ESS Model 750

z/VM V5R1 supports the ESS Model 750, a new model in the family of Enterprise Storage Servers. It provides an entry point into the ESS product family comprised of the ESS Model 750, the ESS Model 800, and the ESS Model 800 with Turbo Processor. The ESS Model 750 is intended to meet the needs of customers who do not require the full range of capacity and performance scalability offered by the ESS Model 800, but do need enterprise level functionality designed to provide reliable, continuous access to data at an affordable price.

The ESS Model 750 supports FlashCopy® V1 and V2, as well as Peer-to-Peer Remote Copy (PPRC) V1 and V2 for advanced metropolitan or long-distance business continuance and point-in-time copy. The Model 750 also includes support for the zSeries performance enhancers, and Parallel Access Volumes (PAV).

## Internet Protocol Version 6 (IPv6)

z/VM V4R4 provided IPv6 support for OSA-Express Guest LANs operating in QDIO mode. Virtual machines (z/VM and other guest operating systems) in the z/VM Guest LAN environment are able to define and use simulated OSA-Express devices that support both the IPv4 and IPv6 protocols.

IPv6 relieves several constraints in IPv4, such as the limited number of available IP addresses. IPv6 uses 128-bit addresses, an address space large enough that it is expected to last for the foreseeable future. It also adds many improvements to IPv4

## New or Changed

in areas such as routing and network autoconfiguration. IPv6 is expected to gradually replace IPv4, with the two coexisting for a number of years during a transition period.

z/VM V5R1 enhances z/VM's IPv6 support by allowing the z/VM TCP/IP stack to be configured for IPv6 networks connected through OSA-Express operating in QDIO mode. The stack can be configured to provide static routing of IPv6 packets and to send IPv6 Router Advertisements. The native z/VM TCP/IP applications that have been enhanced to support IPv6 are TRACERTE and PING. In addition, support is being provided to help application developers to create socket applications for IPv6 communications. This support includes updates to the C-Language sockets through the Language Environment and the OpenExtensions callable services library (CSL) socket APIs.

For more information, see:

- *z/VM: TCP/IP User's Guide*
- *z/VM: OpenExtensions Callable Services Reference*
- *C/C++ for z/VM: Run-Time Library Reference, SC09-7624*

## ESS PPRC over FCP Connections

z/VM V5R1 provides guest support for using the Peer-to-Peer Remote Copy (PPRC) function of the IBM Enterprise Storage Server (ESS) over FCP connections. Native support is provided by running Device Support Facilities (ICKDSF), Release 17, in a CMS virtual machine.

## ASN-and-LX-Reuse Facility

z/VM V5R1 adds support for guest use of the ASN-and-LX-Reuse Facility when available on the processor. For example, z/OS V1R6 will take advantage of this architectural extension to improve availability by reusing linkage indices in more circumstances than can currently be done.

## 3592 Tape Drive

z/VM V5R1 supports the IBM TotalStorage Enterprise Tape Drive 3592, which offers greater capacity and improved performance over previous 3590 tape drives. The 3592 supports standard read/write media as well as Write Once Read Many (WORM) media. z/VM provides both native and guest support for the 3592.

## Crypto Express2

Crypto Express2 is IBM's third-generation cryptographic hardware feature, which replaces the PCICA and PCIXCC features. Crypto Express2 combines the functions of both PCICA and PCIXCC in one feature, providing improved secure-key operations. z/VM V5R1 provides z/OS and Linux on zSeries guest support for Crypto Express2 as described for the PCIXCC feature (see "PCIX Cryptographic Coprocessor (PCIXCC)" on page 17). Refer to the 2084/2086 PSP buckets to identify any required service for support of these features.

## OSA-Express2

OSA-Express2 is a new generation of the OSA-Express Gigabit Ethernet feature, as well as a new 10-Gigabit Ethernet feature. This technology update, which z/VM V5R1 can exploit, can help to provide a balanced system with sufficient throughput to satisfy the bandwidth demands of your applications. The OSA-Express2 Gigabit

Ethernet (GbE) and 10 Gigabit Ethernet (10 GbE) features support Queued Direct Input/Output (QDIO). Refer to the 2084/2086 PSP buckets to identify any required service for support of these features.

## TotalStorage DS8000

With the PTF for **APAR VM63534**, z/VM V5R1 supports the new IBM TotalStorage DS8000, which is designed to provide unmatched functionality, flexibility, and performance for enterprise disk storage. The DS8000 enables the creation of multiple storage LPARs (logical partitions), which can be used for completely separate production or test environments in a single physical DS8000. This may enable the use of one storage server where more than one may have been needed in the past. The DS8000 may also provide up to six times the throughput of an ESS Model 800, which may enable workload consolidation into a single storage subsystem.

On the DS8000, z/VM V5R1 supports the definition of emulated FBA disks (SCSI FCP disks) up to 2,147,483,640 512-byte blocks (1 terabyte minus 1 page) in size. z/VM V5R1 also supports the definition of a 3390 Model 9 disk up to 65520 cylinders in size (with the exception of CMS and GCS, which allow access to a 3390 Model 9 up to 32767 cylinders).

**Note:** Because the CMS file system requires file status and control information to reside below 16 MB in virtual storage, there is a practical limitation on the size of CMS minidisks. As a minidisk increases in size, or more files reside on the disk, the amount of virtual storage associated with the disk for CMS file system status and control increases in storage below 16 MB. The current ECKD DASD limitation is 32767 cylinders for a 3390 disk on an ESS device, or about 22 GB of data. IBM suggests that customers defining FBA SCSI disks for use by CMS should set a practical limit of about 22 GB. If larger disks are defined, they should be limited to contain very few files, or the CMS file system may not be able to obtain enough virtual storage below 16 MB to format or access those disks. For more information, see the ACCESS command in the *z/VM: CMS Commands and Utilities Reference*. The maximum size for FBA SCSI disks supported for use by CMS or GCS is 381 GB.

## TotalStorage DS6000

With the PTF for **APAR VM63535**, z/VM V5R1 supports the new IBM TotalStorage DS6000, which is designed to deliver enterprise-class storage capabilities in a space-efficient, modular design. Depending on workload, the DS6000 can provide up to four times the maximum host I/O operations per second of an ESS Model 750.

z/VM V5R1 supports the definition of large SCSI FCP disks and 3390 Model 9 disks on the DS6000, as described above for the DS8000.

## FICON Express2

z/VM V5R1 supports the new FICON Express2 feature for the z890 and z990, which provides up to twice the number of channels in the same amount of physical space – up to 80 FICON Express2 channels on z890 and up to 240 FICON Express2 channels on z990. FICON Express2 is designed to deliver up to 270 megabytes per second (MBps) of throughput, depending upon application environment. By comparison, FICON Express delivers up to 170 MBps. A FICON Express2 channel can also process significantly more start I/Os per second than a

## New or Changed

| FICON Express channel. FICON Express2 supports CHPID types FC (native  
| FICON, including FICON CTC control units) and FCP (Fibre Channel Protocol for  
| attachment to SCSI devices in z/VM and Linux on zSeries environments).

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## Systems Management Improvements

This section describes z/VM systems management improvements that help to provide self-configuring, self-managing, and self-optimization facilities.

## Installation and Service Enhancements

The automated service process has been updated to include:

- An easier query of RSU levels and individual PTF levels for a component
- Cataloging service memo files online and easily displaying them using the VMFUPDAT command
- A new command, LOCALMOD, to automate the local modifications procedure

To help improve the ease-of-use for installing Linux with your z/VM system, spool and page space has been removed from the System Residence volume, and separate installation volumes for spooling and paging are now assigned by the user.

For more information, see:

- *z/VM: Guide for Automated Installation and Service*
- *z/VM: VMSES/E Introduction and Reference*

## Performance Toolkit Enhancements

The Performance Toolkit for VM was introduced in z/VM V4R4 as an optional feature derived from the FCON/ESA program (5788-LGA), which was not available in all countries. The Performance Toolkit provides enhanced capabilities for a z/VM systems programmer, operator, or performance analyst to monitor and report performance data.

The Performance Toolkit feature available with z/VM V4R4 included functional equivalence to the RealTime Monitor (RTM) optional feature. The Performance Toolkit has been enhanced in z/VM V5R1 by providing functional equivalence to the Performance Reporting Facility (PRF) optional feature, thereby eliminating the need for separate products (PRF and RTM) to help manage your performance more efficiently.

Other enhancements include:

- High-level Linux reports based on Application Monitor records from Linux on zSeries guests
- Report for SCSI disks
- z/VM HELP files for all Performance Toolkit commands and messages

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

## Systems Management APIs

The systems management APIs, introduced in z/VM V4R4, provide a basic set of functions that may be called by applications to allocate and manage resources for guests running in z/VM virtual machines (virtual images). Although these APIs are primarily intended for managing Linux virtual images, they can be used to manage many types of z/VM virtual machines. The APIs are designed so that applications

can be more easily written by customers or solution providers to help administrators, especially those who lack in-depth VM knowledge, to manage large numbers of virtual images running in a single z/VM system.

Client applications invoke the systems management APIs through a set of IBM-supplied remote procedure calls (RPCs) to a z/VM server virtual machine (either remotely or from within the z/VM system). The server then calls a set of callable services library (CSL) routines, which perform the requested functions. The CSL routines are replaceable to allow customized solutions for the systems management API functions.

All enhancements to the systems management APIs in z/VM V5R1 have been implemented using Version 2 (V2) of the RPC server. Previous APIs implemented using V1 of the RPC server can also function with the new V2 server. A new server security identification procedure is provided for special authorized clients, which can remove the need to log on with a password, simplifying the logon process. In addition to some usability enhancements, new functions include:

- DASD volume management for virtual images
- Virtual Machine Resource Manager (VMRM) configuration file management
- Query VMRM measurement data
- Query status of active images

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

The Systems Management APIs require a directory manager that supports a set of systems management functions. The IBM z/VM Directory Maintenance Facility (DirMaint) feature, Function Level 510, has been enhanced to support the new API functions. For more information, see the *z/VM: Directory Maintenance Facility Commands Reference*.

## Additional Performance Toolkit Enhancements

With the PTF for **APAR VM63580**, the Performance Toolkit supports monitor records created by the SUSE LINUX 2.6 kernel.

With the PTF for **APAR VM63603**, the Performance Toolkit supports the collection of data on Queued Direct I/O (QDIO) activity, such as OSA-Express and FCP.

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

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## Application Support

This section describes new or enhanced z/VM application development facilities and support provided by other products to support application development and deployment on z/VM.

### New Debug Tool

The IBM Debug Tool for z/VM, V4.1 (5654-A23), available as a chargeable feature of the z/VM V5 System Delivery Offering (SDO), is an interactive source-level debugging tool for compiled applications. It helps you increase debugging efficiencies and helps to reduce application development cycle times. This aid for program testing and analysis helps you examine, monitor, and control the execution of application programs written in C, C++, COBOL, or PL/I on a z/VM system. By

## New or Changed

using the disassembly view, Debug Tool can also support programs compiled with the NOTEST compiler option and applications that include other languages such as Assembler.

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## Packaging Modifications and Withdrawal of Functions or Support

This section identifies functions or support that have been removed from z/VM and describes changes to the contents of the z/VM product package and the z/VM System Delivery Offering (SDO).

### Removal of CP Functions

z/VM V5R1 is designed to operate only on IBM zSeries, or equivalent servers that support IBM z/Architecture (64-bit). As a result, certain functions are not provided by z/VM V5R1:

- IPL from a 31-bit image of the CP nucleus
- Preferred guest (V=R and V=F) virtual machines
- Paging of the CP nucleus

### Removal of the SPTAPE Command

Delivery of z/VM V5R1 satisfies a 2002 Statement of Direction in which IBM indicated its intention to remove the SPTAPE command, which was superseded by the SPXTAPE command, offering superior function and speed. In z/VM V5R1, SPXTAPE has replaced SPTAPE for backup and recovery of spool files, and SPTAPE has been removed. Backup tapes made with SPTAPE cannot be restored to a z/VM Version 5 system.

### I/O Devices Not Supported

In addition to devices not supported by previous releases of z/VM, the following I/O devices are not supported by z/VM V5R1:

- 3370 DASD
- 3375 DASD
- 3380 DASD on 3880 DASD Control Unit

**Note:** Emulated 3380 devices on 3990 Model 2 or higher controllers will continue to be supported. This includes RAMAC<sup>®</sup> emulated 3380 models and 3390 DASD running in 3380 track compatibility mode.

- Multiprise<sup>®</sup> Internal Disk
- 3830 DASD Control Unit
- 3880 DASD Control Unit
- 3995 Optical Library Dataserver
- 9332 DASD
- 9335 DASD
- 9336 DASD, except simulated VDISKs and emulated SCSI LUNs
- 9340 DASD Subsystem, including all associated DASD and controllers
- 2440 Tape Unit
- 3420 Tape Unit
- 3422 Tape Unit and Control, except OMA/2 CD devices that emulate 3422s (supported for installation only)
- 3424 Tape Subsystem
- 3430 Tape Unit

- 9348 Tape Unit
- 3803 Tape Control Unit
- 9221 DASD/Tape Subsystem Control
- SDLC Integrated Communication Attachment
- BSC Integrated Communication Attachment
- CETI (9221) Integrated Communication Attachment

Omission of a device from this list does not mean that the device is supported. For a list of the devices that are supported by z/VM V5R1, see Appendix C, “IBM Devices Supported by z/VM,” on page 95.

## Product and SDO Packaging Modifications

The packaging of the z/VM V5R1 product and the z/VM V5 SDO have been modified as follows:

- The 3270 PC File Transfer product (5664-281), which previously could be ordered with the z/VM V4 SDO, is now available as part of the z/VM V5R1 product. It is shipped as a sample program on the system disk, with no support available.
- The restricted source feature, available as a no-charge feature that could be ordered with z/VM Version 4, and the PL/X source, provided with the installation media in z/VM Version 4, are not shipped with z/VM V5R1 and cannot be ordered with z/VM V5R1. Both will be available as no-charge downloads from IBM Resource Link™ at [www.ibm.com/servers/resourceLink/](http://www.ibm.com/servers/resourceLink/).

**Note:** If you are not registered with Resource Link, you will be required to register for a user ID and password. You must also be licensed for z/VM V5R1, and entitlement will be verified when you request the source code. After approval, you will receive instructions describing how to download the code.

- DFSMS/VM®, previously provided automatically with z/VM Version 4, will no longer be shipped automatically. It can be ordered as a no-charge feature with the z/VM V5 SDO.
- The national language features for Interactive System Productivity Facility (ISPF), program number 5684-043, have been removed from the z/VM SDO. These features can still be ordered using the standalone ordering process.
- Tivoli Storage Manager (TSM) for VM, Version 4 (5697-TS9) Release 4.2, which was packaged on the z/VM V4 system DDRs, is not provided with z/VM V5R1 and cannot be ordered with the z/VM V5 SDO. To protect data on z/VM, IBM recommends TSM for z/OS and z/VM, V5.2 (5698-A13), or TSM Extended Edition for z/OS and z/VM, V5.2 (5698-A11). If you want to run TSM in a Linux guest environment on z/VM V5R1, IBM recommends TSM, V5.2 (5608-ISM), or TSM Extended Edition, V5.2 (5608-ISX).
- The Java and NetRexx™ programs on z/VM, previously available as downloads from the z/VM Web site, are not supported with z/VM V5R1. Refer to [www.ibm.com/eserver/zseries/zvm/java/](http://www.ibm.com/eserver/zseries/zvm/java/) for additional information. Java and NetRexx functionality can be obtained from Linux running on z/VM.
- The RealTime Monitor (RTM) and Performance Reporting Facility (PRF) features cannot be ordered with z/VM V5R1, nor can they be licensed with z/VM V5R1.
- The IBM Debug Tool for z/VM, V4.1 (5654-A23), is available as a chargeable feature of the z/VM V5 SDO.

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## Statement of Direction

- z/VM V5R1 is in evaluation for Common Criteria (ISO/IEC 15408) certification using the Labeled Security Protection Profile (LSPP) and the Controlled Access Protection Profile (CAPP), both at the EAL3+ assurance level. The certification will include a new z/VM publication, the *z/VM: Secure Configuration Guide*, SC24-6138.
- IBM intends to support greater than 24 CPs in a single z/VM image in the future on appropriate releases of z/VM in combination with designated zSeries server(s).
- z/VM V5R1 is the last release of z/VM to support the use of the IBM 2741 and TWX Terminal Model 33/35 (TTY), or their equivalents, as virtual consoles. This includes any ASCII device, such as the IBM 3101 or IBM 3163, that simulates one of these terminal types using the communication controller Emulator Program (EP). These devices continue to be supported for attachment to a virtual machine. Support for remote terminals under the control of VTAM is not affected by this change.
- IBM intends to withdraw the System Administration Facility from a future release of z/VM. Customers using the System Administration Facility to create and manage Linux server images as guests of z/VM should start using other systems management facilities of z/VM, write a client application using the systems management APIs introduced in z/VM V4R4, or acquire a system management application from an IBM solution provider. Documentation is available in the *z/VM: System Administration Facility* publication, SC24-6034, but this publication is not included in the z/VM V5R1 library.
- IBM intends to withdraw the Server-Requester Programming Interface (SRPI) from a future release of z/VM. SRPI was introduced in VM in 1986 to provide a programming interface that enhances the environment of IBM workstations communicating with IBM mainframes operated with VM systems. Customers with applications using SRPI should start using z/VM TCP/IP to provide similar function. Documentation for SRPI is available in the *VM/ESA: Programmer's Guide to the Server-Requester Programming Interface for VM*, SC24-5455, but this publication is not included in the z/VM V5R1 library.
- IBM intends to expand the exploitation of 64-bit support in future z/VM releases to provide better utilization of main storage in configurations larger than 2 GB to help ease constraints imposed by demands for main storage below 2 GB.
- In the future, Linux on zSeries guests running on z/VM may benefit from IBM Virtualization Engine support for Linux on zSeries, which is intended to include Enterprise Workload Manager support for zSeries, Linux on zSeries participation in IBM Director Multiplatform, and the IBM Dynamic Infrastructure for mySAP Business Suite, a solution using Virtualization Engine systems provisioning.

All statements regarding IBM's plans, directions, and intent are subject to change or withdrawal without notice.

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## Chapter 4. Hardware and Software Requirements and Other Technical Information

This chapter identifies the hardware and program (software) requirements of the z/VM V5R1 base product and its optional features. This chapter also includes other technical information about z/VM. It contains the following sections:

- “Hardware Requirements”
- “Device Support” on page 28
- “Program Requirements” on page 29
- “Operating Systems Supported as Guests” on page 36
- “Other Programs Supported on z/VM” on page 36
- “National Language Support” on page 36
- “Packaging and Ordering Information” on page 37
- “Object Code Only and Limited Source Availability” on page 38
- “Limitations and Restrictions” on page 34
- “Integrity and Security” on page 38

**Note:** Some technical information may have changed since this book was published. There may be a later edition of this book. For the latest product updates, you should contact your IBM Support Center or visit the z/VM Web site at [www.ibm.com/eserver/zseries/zvm/](http://www.ibm.com/eserver/zseries/zvm/).

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### Hardware Requirements

This section identifies the hardware and storage required to install and operate z/VM V5R1. It includes the following topics:

- “Server Requirements”
- “Installation Requirements”
- “Minimum Storage Requirements” on page 26
- “CSE Hardware Requirements” on page 26
- “OSA/SF Hardware Requirements” on page 27
- “TCP/IP Hardware Requirements” on page 27
- “VM Guest RSA-Assist Support for Linux Hardware Requirements” on page 28

### Server Requirements

z/VM V5R1 requires a server that supports the 64-bit IBM z/Architecture. See Appendix A, “IBM Servers Supported by z/VM,” on page 87.

Specific server facilities are also required. See the architecture level set information at [www.ibm.com/eserver/zseries/zvm/zvm510/architecture/](http://www.ibm.com/eserver/zseries/zvm/zvm510/architecture/).

### Installation Requirements

z/VM V5R1 is available in the following formats:

- A DASD Dump/Restore (DDR) image on magnetic tape or CD-ROM
- A binary image on DVD

To install z/VM V5R1:

- A local non-SNA 3270 terminal, or equivalent, is required.

## Technical Information

**Note:** The integrated 3270 console available with the z990 and z890 satisfies this requirement. The integrated 3270 console is provided through the IBM Hardware Management Console. Using an integrated 3270 console may require additional hardware support. See Appendix A, “IBM Servers Supported by z/VM,” on page 87.

- Installation from magnetic tape requires a tape drive capable of reading IBM 3480/3490 or 3590 tape cartridges.
- Installation from CD-ROM requires one of the following:
  - Optical Media Attach/2 Program (5621-264)

**Note:** This product has been withdrawn from marketing.

- 2074 Console Support Controller, or equivalent, capable of reading Optical Media Attach (OMA) format
- Installation from DVD requires the IBM Hardware Management Console, Version 1.8.0 or later.
- Installation to extended count key data (ECKD) DASD requires IBM 3390 Model 3 or Model 9 DASD, or DASD that is defined to emulate these specific models.

**Note:** For performance reasons, IBM does not recommend using a real 3390 Model 9.

- Installation to FCP-attached SCSI requires ESS SCSI disks or equivalent.
- Installation first level from tape (3480/3490 or 3590) or CD-ROM requires 10 MB of real storage.
- Installation first level from DVD requires that 512 MB of real storage be assigned to the LPAR where z/VM will be installed.
- Installation second level (from tape, CD-ROM, or DVD) requires 64 MB of virtual storage for the installation user ID on your first level system.

For specific DASD volume requirements, see the *z/VM: Guide for Automated Installation and Service*.

Although a printer is not required to install z/VM, IBM recommends having one available so you can obtain important diagnostic information if you encounter a problem during IPL.

## Minimum Storage Requirements

The minimum real storage needed to generate z/VM is 10 MB, and z/VM requires at least 10 MB of real storage to function.

The block paging function requires more DASD space to transfer pages at maximum efficiency and speed.

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

## CSE Hardware Requirements

The cross system extensions (CSE) function requires certain hardware, as follows:

- The CSE complex consists of two, three, or four VM systems.
- The systems in the CSE complex must be connected by channel-to-channel adapters or an IBM 3088 Multisystem Channel Communications Unit (MCCU).

- DASD shared by systems in the complex must be ECKD devices. Fixed-block architecture (FBA) devices are supported by the CSE function for spooling only.

## OSA/SF Hardware Requirements

The Open Systems Adapter Support Facility (OSA/SF) requires general disk space and a minidisk for each user ID. OSA/SF requires its own user ID and also requires a maintenance user ID for its installation. Refer to the OSA/SF program directory for more information.

To use the OSA/SF graphical user interface, you also need a workstation with sufficient processing and memory capabilities.

A full list of OSA and OSA/SF hardware requirements is beyond the scope of this book. Depending on your OSA type, refer to one of the following:

- *eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature*
- *eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*

## TCP/IP Hardware Requirements

TCP/IP for z/VM requires **one** of the following:

- IBM 3172 Interconnect Controller with the Interconnect Controller Program (ICP) Version 3 (5621-425) or equivalent
- IBM Open Systems Adapter-2 (OSA-2) (supported OSA-2 features are server-dependent)
- IBM Open Systems Adapter-Express (OSA-Express) (supported OSA-Express features are server-dependent)
- IBM Open Systems Adapter-Express2 (OSA-Express2) (supported OSA-Express2 features are server-dependent)
- IBM 37xx Communications Controller using X.25 or SNA connections  
Native attachment of the IBM 3745 to TCP/IP and associated dynamic IP routing within the 3745 are not supported.
- IBM 8232 LAN Channel Station Model 1 or 2
- HYPERchannel A220 Processor Adapter 42990007  
TCP/IP for z/VM supports the HYPERchannel Series A devices (and HYPERchannel Series DX devices that are functioning as Series A devices). For additional information, refer to the appropriate Network Systems Corporation documentation.
- IBM RS/6000<sup>®</sup> Channel Attachment using the Block Multiplexer Channel or ESCON<sup>®</sup> Adapter
- IBM 3088 Multi-system Channel Communication Unit  
TCP/IP for z/VM supports direct connection to another TCP/IP for z/VM, or z/OS, using the IBM 3088.
- IBM ESCON Channel-to-Channel Adapter  
TCP/IP for z/VM supports direct connection to another TCP/IP for z/VM, or z/OS, using the IBM ESCON Channel-to-Channel Adapter.
- IBM FICON Channel-to-Channel Adapter  
TCP/IP for z/VM supports direct connection to another TCP/IP for z/VM, or z/OS, using the IBM FICON Channel-to-Channel Adapter.
- IBM HiperSockets

## Technical Information

VM programs using TCP/IP can communicate using HiperSockets with other VM programs using TCP/IP and with guest operating systems and other logical partitions using TCP/IP.

TCP/IP for z/VM also requires a 3270-equivalent workstation for TCP/IP administration.

## VM Guest RSA-Assist Support for Linux Hardware Requirements

In order for the VM Guest RSA-Assist Support for Linux to operate, corresponding function in Linux on zSeries and one of the following are required:

- IBM Crypto Express2
- IBM PCIX Cryptographic Coprocessor (PCIXCC)
- IBM PCI Cryptographic Coprocessor (PCICC)
- IBM PCI Cryptographic Accelerator (PCICA)

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## Device Support

z/VM handles real devices as supported or unsupported.

### Supported Devices

A supported device is one of those listed in Appendix C, “IBM Devices Supported by z/VM,” on page 95. The use of such a device is fully supported by IBM through the service support available with z/VM. A supported device can be supported either for CP and guest use or for dedicated use by only a single guest.

A device supported for CP and guest use is one that CP and virtual machines can use. 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.

A device supported for dedicated use by a single guest can be logically attached to only a single 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 95, 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 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 or

CP-owned device. You define an unsupported device by calling it a device type other than any of those shown in Appendix C, “IBM Devices Supported by z/VM,” on page 95, and by specifying the CLASS operand of the RDEVICE macro. The CLASS value should be the one that comes closest to accurately describing the unsupported device (for example, DASD or TAPE). See *z/VM: CP Planning and Administration* for details of the definition and customization processes for unsupported devices.

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## Program Requirements

This section identifies the additional licensed programs and other program materials required by z/VM V5R1. It includes the following topics:

- “Prerequisite Licensed Programs”
- “Tasks that Require the High Level Assembler”
- “Required Levels of z/VM Facilities and Features” on page 30
- “Additional z/VM Base Program Requirements” on page 30
- “Shared-DASD Complex and CSE Cluster Program Requirements” on page 30
- “DFSMS/VM Program Requirements” on page 31
- “DirMaint Program Requirements” on page 31
- “Language Environment Program Requirements” on page 32
- “OpenExtensions Program Requirements” on page 32
- “OSA/SF Program Requirements” on page 32
- “Performance Toolkit Program Requirements” on page 32
- “RACF Program Requirements” on page 33
- “TCP/IP Program Requirements” on page 33
- “Online Books Program Requirements” on page 34
- “Program Requirements for Other IBM Products” on page 34
- “Linux Program Requirements” on page 34

## Prerequisite Licensed Programs

z/VM V5R1 requires the following additional IBM licensed programs:

- Environmental Record Editing and Printing (EREP/VM), Version 3 (5654-260) Release 5.0
- Device Support Facilities: ICKDSF for VM, Version 1 (5684-042) Release 17 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 G14. 'G' indicates Release 17 of ICKDSF and '14' indicates VMSES/E format.

**Note:** EREP/VM and ICKDSF are included on the z/VM System Image and are automatically installed. Therefore, when ordering z/VM, you must already be licensed for these programs or you must also place orders for them to establish licenses. Both the CMS version of ICKDSF and an IPLable standalone version (5747-DS1) are supplied with z/VM.

## Tasks that Require the High Level Assembler

Although not a prerequisite for z/VM, the IBM High Level Assembler, Version 1 (5696-234), is required for many z/VM tasks and functions:

- Release 2.0 or later is required to:
  - Create a new DMSTRT for system languages (NLS)
  - Create image libraries for system printers (FCBs)

## Technical Information

- Create GCS application segments (CONTENTS macro)
- Access major CMS application interfaces (CMSCALL)
- Access most CP application interfaces (DIAGNOSE)
- Modify the AVS tuning control module (AGWTUN)
- Use RAS tools (such as MDCHECK, FS2SFSE, AFTCHAIN, PRINTBLK, and PRINTFST)
- Use the API for data compression
- Use the CMS pipelines assembler macro interface
- Customize Language Environment or compiling assembler routines used in mixed-language user applications
- Use exit routines in z/VM features, such as DirMaint, or in VM-related products, such as RSCS
- Release 3.0 or later is required for:
  - Run applications that exploit the IEEE Floating Point hardware facility
- Release 4.0 or later is required for:
  - Add devices that cannot be sensed (updating HCPRIO ASSEMBLE)
  - Perform local modifications to modules written in assembler
  - Service the CP Loader (HCPLDR)
  - Create the Stand-Alone Dump Utility (HCPSADMP EXEC)
  - Assemble any CP modules
  - Use CP exit routines
  - Reassemble CP replacement parts for the RACF for z/VM optional feature

## Required Levels of z/VM Facilities and Features

z/VM V5R1 supports only the levels of the facilities supplied in the z/VM V5R1 base product or available as optional features of z/VM V5R1. Previous levels of these base facilities and optional features are not supported with z/VM V5R1. Additional service for z/VM V5R1 facilities and optional features may also be required to support some functions.

## Additional z/VM Base Program Requirements

The following programming enhancements were provided after the general availability of z/VM V5R1:

- To support LUN access control for SCSI FCP disks connected to a FICON Express on a z890 or z990, the PTF for APAR VM63328 is required.
- To support additional device connections (TCP/IP stacks) on an OSA-Express or OSA-Express2 on a z890 or z990, the PTF for APAR VM63524 is required. (Also see “TCP/IP Program Requirements” on page 33.)
- To support the IBM TotalStorage DS8000, the PTF for APAR VM63534 is required.
- To support the IBM TotalStorage DS6000, the PTF for APAR VM63535 is required.
- To support Layer 2 mode on a Virtual Switch for an OSA-Express or OSA-Express2 on a z890 or z990, the PTF for APAR VM63538 is required. (Also see “TCP/IP Program Requirements” on page 33.)

## Shared-DASD Complex and CSE Cluster Program Requirements

In a shared-DASD complex, a single Directory Maintenance Facility (DirMaint) server with a single source directory can manage the object directory on up to 16

z/VM systems, if the DirMaint executable code disks and source directory disk are shared among all the systems. The following are required to support the shared-DASD complex:

- Directory Maintenance Facility, Function Level 510 (FL510)  
 Within the shared-DASD complex, all z/VM systems must be running the same DirMaint FL510 service level. Therefore, you must be licensed for the DirMaint FL510 feature on any z/VM V5 system in the complex; you must be licensed for the DirMaint FL410 feature on any z/VM V4 system in the complex; and you must be licensed for the IBM Directory Maintenance VM/ESA program product, Version 1 (5748-XE4) Release 5.0, on any z/VM V3 system in the complex.

A CSE cluster consists of two, three, or four z/VM systems. The following are required to support the CSE function:

- The same DirMaint requirements as for the shared-DASD complex described above.
- For shared spool and cross-system messaging:
  - VM/Pass-Through Facility, Version 2 (5684-100) Release 1.1 or later

## DFSMS/VM Program Requirements

DFSMS/VM requires the following:

- To use the Interactive Storage Management Facility (ISMF) functions:
  - Interactive System Production Facility (ISPF), Version 3 (5684-043) Release 2.0 or later

**Note:** ISPF is not required if only 3495 Tape Library Dataserver support is needed.
- To use the minidisk management functions:
  - Directory Maintenance Facility, Function Level 510
- If an external security manager is needed:
  - RACF for z/VM, or an equivalent product
- To use the Migration Level 2 (ML2) function:
  - Tivoli Storage Manager Extended Edition for z/OS and z/VM V5.2 (5698-A11), Tivoli Storage Manager for z/OS and z/VM V5.2 (5698-A13), or Tivoli Storage Manager for VM (5697-TS9)
  - Language Environment 1.8 or later
- 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, Level 510
- For remote operations:
  - Remote Spooling Communications Subsystem Networking (RSCS), Version 3 (5684-096) Release 2.0 or later
- 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)

## DirMaint Program Requirements

To support SCSI disks (emulated 9336-20 disks) larger than 79999992 512-byte blocks (381 GB) and 3390 Model 9 disks larger than 32760 cylinders on the IBM TotalStorage DS8000 and DS6000, the PTF for APAR VM63656 is required.

### Language Environment Program Requirements

To customize Language Environment, or to compile assembler routines included in mixed-language user applications, you need the following licensed program:

- IBM High Level Assembler, Version 1 (5696-234) Release 2.0 or later

### OpenExtensions Program Requirements

To develop OpenExtensions applications in C, you need:

- One of the following compilers:
  - IBM C/C++ for z/VM, Version 1 (5654-A22) Release 1.0
  - IBM C for VM/ESA, Version 3 (5654-033) Release 1.0
- Language Environment:
  - If you compile your C program with C/C++ for z/VM, you must use the C/C++ run-time library included in the Language Environment component of z/VM.
  - If you compile your C program with C for VM/ESA, you can use either the C run-time library included in Language Environment 1.8 or the C/C++ run-time library included in the Language Environment component of z/VM.

To develop OpenExtensions applications in C++, you need:

- IBM C/C++ for z/VM, Version 1 (5654-A22) Release 1.0
- Language Environment component of z/VM

### OSA/SF Program Requirements

OSA/SF is provided with and supported on z/VM and can be accessed by a CMS user ID, a REXX call to the OSA/SF API, or a Java-based graphical user interface (GUI). The GUI needs access to the Java 1.4 runtime and help on the workstation.

Access through the OSA/SF GUI requires the following communications protocols:

- For TCP/IP communication:
  - TCP/IP for z/VM, Level 510, on the host
  - TCP/IP on the workstation

To support an OSA in its TCP/IP Passthru mode in a z/VM V5R1 environment, OSA/SF requires TCP/IP for z/VM, Level 510. OSA/SF is required in this mode only if access to one of the OSA's ports is being shared by more than one host program or if an ATM OSA-2 is being used as a LAN Emulation Client (LEC).

For more information about the program requirements for OSA/SF for your OSA type, see one of the following:

- *eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature*
- *eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*

### Performance Toolkit Program Requirements

To support monitor records created by the SUSE LINUX 2.6 kernel, the PTF for APAR VM63580 is required.

To support the collection of data on QDIO activity, the PTF for APAR VM63603 is required.

## RACF Program Requirements

To reassemble CP replacement parts for RACF for z/VM, you need the following licensed program:

- IBM High Level Assembler, Version 1 (5696-234) Release 4.0 or later

For possible additional program requirements, see *Resource Access Control Facility: General Information*.

## TCP/IP Program Requirements

TCP/IP for z/VM has the following additional program requirements:

- If the SSL server is to be run, one of the following Linux distributions must be installed and configured for exclusive use by the SSL server:
  - SUSE LINUX 2.4.7 SLES 7, with IUCV driver patch linux-2.4.7-s390-8-iucv
  - SUSE LINUX 2.4.19 SLES 8
  - Turbolinux Enterprise Server 8 (TLES 8)
- If a primary or secondary domain name server is to be run (not a caching-only name server), or the Network Data Base server is to be run:
  - IBM DB2 Server for VSE & VM, Version 6 (5648-A70), or IBM DB2 Server for VSE & VM, Version 7 (5697-F42)
- For SNAlink LU0 interface support:
  - ACF/VTAM for VM/ESA, Version 4 (5654-010)
- For X.25 interface support:
  - X.25 NCP Packet Switching Interface (NPSI), Version 3 (5688-035) Release 4 or later, for 3745 or 3720
  - X.25 NPSI, Version 2 (5668-719) Release 1, for 3725
  - Corresponding levels of ACF/VTAM and ACF/NCP that support NPSI
- If an external security manager is needed:
  - RACF for z/VM, or an equivalent product
- To develop programs in C:
  - One of the following compilers:
    - IBM C/C++ for z/VM, Version 1 (5654-A22) Release 1.0
    - IBM C for VM/ESA, Version 3 (5654-033) Release 1.0
  - Language Environment:
    - If you compile your C program with C/C++ for z/VM, you must use the C/C++ runtime library included in the Language Environment component of z/VM.
    - If you compile your C program with C for VM/ESA, you can use either the C runtime library included in Language Environment 1.8 or the C/C++ runtime library included in the Language Environment component of z/VM.
- To develop programs in Pascal:
  - IBM VS Pascal, Version 1 (5668-767) Release 2, Compiler and Library
- To support additional device connections (TCP/IP stacks) on an OSA-Express or OSA-Express2 on a z890 or z990, the PTF for APAR PQ91421 is required. (Also see “Additional z/VM Base Program Requirements” on page 30.)
- To support Layer 2 mode on a Virtual Switch for an OSA-Express or OSA-Express2 on a z890 or z990, the PTF for APAR PQ98202 is required. (Also see “Additional z/VM Base Program Requirements” on page 30.)

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

## Online Books Program Requirements

z/VM online books are provided in two formats: Adobe Portable Document Format (PDF) and IBM BookManager®.

### PDF Books

To open and view PDF books on your workstation, the Adobe Reader is required (3.0 or later is required; 4.0 or later is recommended). You can also use the Adobe Reader to print PDF books or sections of PDF books. The Adobe Reader is available free from the Adobe Web site at [adobe.com](http://adobe.com).

### BookManager Books

To view BookManager books loaded on the z/VM system, IBM BookManager READ/VM (5684-062) Release 3 or later is required. This program has the following prerequisite licensed programs:

- GDDM®/VM, Version 3 (5684-168) Release 1.1 or later
- Language Environment 1.8 or later
- Compiler for SAA REXX/370 (5695-013) or Library for SAA REXX/370 (5695-014)

To run READ/VM Public Library, the PTF for BookManager APAR GC05366 is required.

To view and search BookManager files and bookshelves on a Windows workstation, the IBM Softcopy Reader is required. This program is included on the *IBM eServer zSeries Online Library: z/VM Collection* CD-ROM supplied with z/VM.

For possible additional program requirements, refer to the BookManager announcement documentation.

## Linux Program Requirements

Linux on zSeries is not provided with z/VM. Linux must be obtained from distributors or with an IBM-available offering, such as the IBM @server Integrated Platform for e-business on zSeries. Corresponding exploitation in Linux on zSeries is required for specific functions to work correctly in a z/VM environment.

For the most current information on Linux distributions, see [ibm.com/eserver/zseries/os/linux/dist.html](http://ibm.com/eserver/zseries/os/linux/dist.html).

## Program Requirements for Other IBM Products

Other IBM licensed products might also have additional program requirements to run on z/VM V5R1. Refer to the product documentation and product Web sites. See the IBM VM-related licensed products and features page at [www.ibm.com/eserver/zseries/zvm/related/](http://www.ibm.com/eserver/zseries/zvm/related/).

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## Limitations and Restrictions

z/VM V5R1 has the following limitations:

- z/VM V5R1 will operate only on IBM zSeries (z890, z990, z800, and z900), or equivalent servers that support the 64-bit IBM z/Architecture.

- Linux is the only guest operating system that z/VM V5R1 will support on IBM Integrated Facility for Linux (IFL) engines (other than z/VM V4 or z/VM V5). Linux can also run on IFL engines in LPAR mode.
- Use of IFL engines on z800 and z900 machines requires LPAR mode. Customers who choose to add IFL engines to a z800 or z900 machine running in basic mode will also have to run their operating system on the standard engine(s) in LPAR mode. This is not a consideration for z990 and z890 machines, which do not have basic mode.
- z/VM V5R1 does not provide support for V=R or V=F guest images. Customers currently running V=R or V=F guests should consider this when migrating to z/VM V5R1. The processor requirements to run as a V=V guest, if the guest was previously run as V=R, may be significant due to the loss of various hardware assists.
- z/VM does not support the reconfiguration of partitionable processors, either by z/VM itself or by guests running on z/VM.

## General Restrictions for z/VM Virtual Machines

z/VM virtual machines have the following general restrictions:

- 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.
- The CPUID that appears in most EREP records is not the same as the CPUID of the physical processor on which the error occurred (because there is more than one partition per physical processor in LPAR mode).

## DirMaint Restrictions

The following restrictions apply to Directory Maintenance Facility, Function Level 510:

- User IDs defined for DirMaint must conform to the CMS file naming convention. Each profile name and user ID must be unique. The names \$DIRCTL\$ and \$DIRGRP\$ are reserved for DirMaint's use. Names in the form \$DIRxxx\$ should be avoided because they are reserved for possible future use by DirMaint.
- The display of menus requires a 3270-compatible terminal with a minimum of 24 lines and at least an 80 column line length.
- Exits may require tailoring for use with RACF or other external security managers.
- Although minimal, some changes are made to the system directory as a side effect of using DirMaint:
  - All addresses are expanded to four digits (if not already so) when the source directory is converted to DirMaint's internal format. When the internal format is converted back to the CP or DIRECTXA external format, the four-digit address expansion is maintained.
  - When converted to DirMaint's internal format, most directory statements are uppercased and excessive blanks are removed between the statement operands. When the internal format is converted back to the external format, the uppercasing and single spacing are maintained. Comments, POSIX, and optionally the ACCOUNT statements are excluded from this conversion.
  - Only one copy of NOPDATA per System Affinity group is retained. If multiple copies of NOPDATA exist in the user's directory, DirMaint strips out the excessive copies during initialization.
- DirMaint does not allow the use of &SYSRES for a volume identification on an MDISK directory statement. The value of +VMRES is supported, with some

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restrictions. The use of +VMRES is reserved by CP and should not be used as the real volume label of a physical DASD volume. The value of the synonym may be changed by including the &SYSRES parameter on the DIRECTXA\_OPTIONS entry in the CONFIG\* DATADVH files.

For example, DIRECTXA\_OPTIONS= MIXED NOMIXMSG &SYSRES VM:RES tells DirMaint, DIRECTXA, and CP to use VM:RES as the synonym rather than +VMRES.

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## Operating Systems Supported as Guests

For information about the specific levels of IBM operating systems supported as guests, see Appendix B, “IBM Operating Systems Supported as Guests of z/VM,” on page 91.

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## Other Programs Supported on z/VM

For information about other IBM licensed programs supported on z/VM, see [www.ibm.com/eserver/zseries/zvm/related/](http://www.ibm.com/eserver/zseries/zvm/related/).

For information about non-IBM Solution Developer products that run on z/VM, see [www.ibm.com/eserver/zseries/zvm/vendor/](http://www.ibm.com/eserver/zseries/zvm/vendor/).

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## National Language Support

The system default language for z/VM is mixed-case American English. z/VM's national language support allows you to install a language other than American English on your z/VM system. End users can selectively (through commands) receive messages and HELP information in that language. Any installed language can be set as the system default language. Each session on the same system can select a language that is different from another session, as long as the language selected has been installed on that system. For example, one user can be using German while another user is using Japanese.

In addition to mixed-case American English, z/VM includes uppercase American English and provides the IBM-translated components, facilities, and features listed in the following table.

**Note:** Some parts of the listed items may not be translated.

*Table 1. IBM-Translated Parts of z/VM*

Language	IBM-Translated Parts of z/VM
German	<ul style="list-style-type: none"><li>• CP messages, HELP for CP commands and messages</li><li>• CMS messages, HELP for CMS commands and messages</li><li>• REXX/VM messages, HELP for REXX/VM statements and messages</li></ul>
Japanese (KANJI)	<ul style="list-style-type: none"><li>• CP messages, HELP for CP commands and messages</li><li>• CMS messages, HELP for CMS commands and messages</li><li>• REXX/VM messages, HELP for REXX/VM statements and messages</li><li>• DFSMS/VM panels and messages</li><li>• DirMaint messages</li></ul>

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## Packaging and Ordering Information

To order z/VM V5R1 and its features, as well as other licensed products that run on z/VM, order the z/VM Version 5 (V5) System Delivery Offering (SDO), program number 5741-A06. The z/VM V5 SDO package contains:

- z/VM V5R1 System Image
- z/VM SDO Optional Products Enabling Aid
- z/VM SDO licensed products and optional features, if ordered

For more information about the z/VM V5 SDO, see [ibm.com/eserver/zseries/zvm/sdo/](http://ibm.com/eserver/zseries/zvm/sdo/).

The z/VM V5R1 System Image is available as:

- A multivolume 3390 DASD Dump Restore (DDR) image on 3480/3490 or 3590 tape cartridges or CD-ROM
- A binary image on DVD

The z/VM V5R1 System Image contains:

- z/VM base:
  - CP
  - CMS
  - TCP/IP for z/VM (includes source)
  - AVS
  - Dump Viewing Facility
  - GCS
  - HCD and HCM for z/VM
  - Language Environment
  - OSA/SF
  - REXX/VM
  - TSAF
  - VMSES/E
  - SFS and CRR file pools
  - DASD Dump Restore (DDR) program
  - Translated CP and CMS message repositories
  - English and translated HELP files
  - 3800 printer image library object code
  - 3800 printer image library source
- z/VM optional features:
  - DirMaint
  - Performance Toolkit
  - RACF for z/VM
- Selected related IBM licensed programs:
  - EREP/VM, Version 3 (5654-260) Release 5
  - ICKDSF for VM, Version 1 (5684-042) Release 17 (includes ICKDSF Standalone Release 17)
  - RSCS, Version 3 (5684-096) Release 2.0

### Notes:

1. The DirMaint, Performance Toolkit, and RACF for z/VM optional features are included in the z/VM V5R1 System Image for convenience. They are installed disabled. If you decide to use any of these features, you must place orders for them so that you can enable them.

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2. The DFSMS/VM optional feature is not supplied automatically with z/VM V5R1. If desired, DFSMS/VM must be ordered as a no-cost optional feature of the z/VM V5 SDO.
3. ICKDSF, EREP/VM, and RSCS are not part of the z/VM product. They are separate IBM licensed programs that are included in the z/VM V5R1 System Image for convenience. ICKDSF and EREP/VM are prerequisites of z/VM. Before using ICKDSF and EREP/VM you must be already licensed for them, or you must place orders for them to establish licenses. RSCS is installed disabled. If you wish to use RSCS, you must place an order to establish a license so that you can enable it.

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## 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
- SSL server included with TCP/IP for z/VM
- DFSMS/VM
- Performance Toolkit

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

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## Integrity and Security

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

### Data Integrity for Guests

Operating system failures that occur in virtual machines do not normally affect the z/VM operating system 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 testing and production work running in other virtual machines.

### System Integrity Statement for z/VM

System integrity is an important characteristic of z/VM. This statement extends IBM's previous statements on system integrity to the z/VM environment.

IBM has implemented specific design and coding guidelines for maintaining system integrity in the development of z/VM. Procedures have also been established to make the application of these design and coding guidelines a formal part of the design and development process.

However, 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, as defined in the following "z/VM System Integrity Definition" on page 39 section.

IBM will continue its efforts to enhance the integrity of z/VM and to respond promptly when exposures are identified.

### **z/VM System Integrity Definition**

The z/VM control program system integrity is the inability of any program running in a virtual machine not authorized by a z/VM control program mechanism under the customer's control or a guest operating system mechanism under the customer's control to:

- Circumvent or disable the control program real or auxiliary storage protection.
- Access a resource protected by RACF. Resources protected by RACF include 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/virtual disks through channel program translation.

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

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

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.

### **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's commitment to the system integrity of the z/VM environment, as described in this statement, represents a further significant step 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 may 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 VM system facilities to:

- Protect the DirMaint service machines (DIRMAINT, DATAMOVE, DIRMSATs) from subversion
- Protect files from outside interference or contamination

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- 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

The DIRMAINT and DIRMSAT service machines require the appropriate CP privilege class to use CP commands and DIAGNOSE codes. These machines benefit from use of the OPTION D84NOPAS directory statement, and security is enhanced with the D8ONECMD FAIL LOCK directory statement. Data integrity is enhanced when the optional DATAMOVE service machines have LNKSTABL and LNKEXCLU specified on the OPTION statement in their directory entries.

## 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 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 class restructure provides customers with the ability to control access to commands and DIAGNOSE codes more precisely through customer-defined classes.
- Journaling is supported on z/VM. In addition, the optional RACF feature provides customers with many of these facilities, as well as other security capabilities.
- 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.

### Support for Cryptographic Facilities on IBM Servers

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

- CMOS Cryptographic Coprocessor is supported for use by guests.
- PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux on zSeries guests.
- PCIX Cryptographic Coprocessor and Crypto Express2 are supported for use by Linux on zSeries guests and z/OS guests.

### 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 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:

- Kerberos authentication service  
The Kerberos authentication server provides a way for authenticated users to prove their identity to other servers in a network. The authentication server uses the Kerberos database to verify that the client making the request is, in fact, the client named in the request.
- Secure Sockets Layer (SSL) support  
SSL provides secure (encrypted) communication between a remote client and a TCP/IP application server. Under SSL protocol, the application server is always authenticated. To participate in an SSL session, an application server must provide a certificate from a Certifying Authority to prove its identity.
- Exits to an ESM  
TCP/IP servers can be configured to use RACF for z/VM or another ESM to:
  - Authenticate and authorize access to resources managed by the server
  - Validate client user IDs and passwords

### 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.
- VM system services are used to identify the originating user ID (and node ID) for all requests, whether local or remote. By default, all requests must be authenticated by providing the correct logon password for each DirMaint

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transaction. Unless prohibited by the system administrator, users may request suspension of authentication for requests made from their user ID within the scope of a multiple system cluster. Remote requests never require authentication, and surrogate requests always 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 customer-tailorable filtering of unnecessary audit details.

### **Security Provided by RACF for z/VM**

RACF 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 checks access to minidisks, data in spool files, 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.

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## Chapter 5. z/VM Base Facilities

This chapter provides an overview of the facilities included in the z/VM base product:

- “Control Program”
- “Conversational Monitor System” on page 49
- “TCP/IP for z/VM” on page 53
- “APPC/VM VTAM Support” on page 56
- “Dump Viewing Facility” on page 56
- “Group Control System” on page 57
- “Hardware Configuration Definition and Hardware Configuration Manager for z/VM” on page 57
- “Language Environment” on page 57
- “Open Systems Adapter Support Facility” on page 58
- “REXX/VM” on page 58
- “Transparent Services Access Facility” on page 58
- “Virtual Machine Serviceability Enhancements Staged/Extended” on page 59

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### Control Program

The Control Program (CP) is primarily a 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 z/OS, 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). ESA virtual machines are also capable of processing according to z/Architecture (64-bit) if switched into that mode by a guest operating system.
- **XA** virtual machines are supported for compatibility and are functionally equivalent to ESA virtual machines. Some CMS applications may require CMS to be running in an XA virtual machine.
- **XC** virtual machines process according to ESA/XC architecture.

**Note:** 370-mode (System/370™ architecture) virtual machines are not supported. However, the 370 Accommodation Facility allows many CMS applications

## Base Facilities

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

A z/VM virtual machine is sometimes called a Virtual=Virtual (V=V) type of virtual machine, because the virtual machine's guest real storage does not permanently map to host real storage. Rather, CP pages the guest real storage into and out of host real storage.

**Note:** The Virtual=Real (V=R) and Virtual=Fixed (V=F) types of virtual machines, also known as preferred virtual machines, which permanently mapped guest real storage to host real storage, are no longer supported.

## Architecture Compatibility

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.

## z/Architecture Support

A guest in an ESA or XA virtual machine may have the capability to issue an instruction to switch the virtual machine from ESA/390 mode to z/Architecture mode. z/Architecture guests can use z/Architecture facilities in z/VM, such as 64-bit arithmetic and addressing.

## ESA/XC Support

z/VM uses extensions to the interpretive-execution facility to provide the Enterprise Systems Architecture/Extended Configuration (ESA/XC) virtual machine architecture. ESA/XC is an architecture unique to virtual machines. Because it exists mainly to provide services to application programs in virtual machines, ESA/XC architecture does not have a native-mode equivalent.

ESA/XC architecture lets virtual machines share multiple data spaces. An XC virtual machine can access one or more data spaces of another virtual machine if so authorized. This is extremely useful for applications that require one or more virtual machines to serve many users.

## Cross System Extensions

The cross system extensions (CSE) function allows two, three, or four z/VM systems to be linked together in a cluster that provides cross-system functions:

- Cross-system link, which extends the existing CP minidisk access protocols (for minidisk linking) across the CSE cluster
- Cross-system spool, which extends CP spooling
- Cross-system message, query, and other commands
- Support for printer spooling

## Guest LANs and Virtual Switches

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

- Virtual adapters —

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.

- Connectivity for virtual 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 Internet Protocol (IP) switch, known as a Virtual Switch, to an associated real LAN connected by an OSA-Express QDIO adapter. A Virtual Switch allows connectivity to external LAN segments without requiring a router.

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

## 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.

## VM Dump Tool

The VM Dump Tool assists in analyzing dump data from a dump file created by the DUMpload 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 standalone 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 56.

## Support for Hardware Architectures, Facilities, and Features

This section lists *some* of the hardware architectures, facilities, and features that CP supports. In some cases this support is available only to guests.

**Note:** Support for hardware depends on hardware level and availability. See:

- Chapter 3, “What Is New or Changed in z/VM V5R1,” on page 11
- Appendix A, “IBM Servers Supported by z/VM,” on page 87
- Appendix C, “IBM Devices Supported by z/VM,” on page 95

For detailed information on hardware capabilities, requirements, and availability, refer to the appropriate hardware announcements.

### Concurrent-Sense Facility

CP provides guest support for the concurrent-sense facility, which is designed for use on channel paths that support the ESCON I/O interface. This facility allows the

## Base Facilities

channel subsystem to present I/O status information and sense information together, in one I/O operation. This eliminates the wait for sense information whenever status information is received.

### Cryptographic Facilities

CP supports guest use of cryptographic facilities on IBM servers:

- CMOS Cryptographic Coprocessor is supported for guests.
- PCI Cryptographic Coprocessor (PCICC) is supported for Linux on zSeries guests.
- PCI Cryptographic Accelerator (PCICA) is supported for Linux on zSeries guests.
- PCIX Cryptographic Coprocessor (PCIXCC) is supported for Linux on zSeries guests and z/OS guests.
- Crypto Express2 is supported for Linux on zSeries guests and z/OS guests.

CP provides clear-key RSA support for a considerably large number of Linux on zSeries guests, which helps to enable hardware SSL acceleration on zSeries servers.

### ESS FlashCopy

A native CP user or a guest can initiate the IBM TotalStorage Enterprise Storage Server (ESS) FlashCopy feature 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.

### ESS Large Volumes

CP supports 3390 volumes greater than 10,017 cylinders on the ESS, up to the maximum supported by the DASD. This helps relieve device address constraints and improves disk resource utilization and storage administrator productivity by providing the ability to consolidate multiple disk volumes into a single address.

### ESS Parallel Access Volumes

CP provides guest support for the ESS Parallel Access Volumes feature, 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.

### ESS Peer-to-Peer Remote Copy

CP supports the ESS Peer-to-Peer Remote Copy (PPRC) feature, a synchronous copy option that provides real-time mirroring of logical volumes within an ESS or to another ESS.

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, Version 1 Release 17, with ICKDSF running in a CMS virtual machine.

CP also supports guest use of PPRC Version 2, 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.

## Enterprise Systems Connection Architecture®

Enterprise Systems Connection Architecture (ESCON) is built around fiber optic transmission technology. Fiber optic cables reduce cable bulk, allow for increased distance between the processor and attached devices, and improve data transfer rates.

## Expanded Storage

Expanded Storage is an optional integrated high-speed storage facility, available on certain processors, that allows for the rapid transfer of 4 KB blocks between itself and real storage.

## Extended Channel Measurement Data Support

CP supports the Extended Channel Measurement Data Support (ECMDS) provided in the IBM @server zSeries 990 (z990). The extended I/O-measurement facilities in the z990 provide 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 available on certain processors which provides a 128-bit time-of-day (TOD) clock. CP supports the use of the Extended-TOD-Clock Facility from virtual machines.

## Fibre Channel Protocol

CP supports the Fibre Channel Protocol (FCP) hardware channel, which allows an IBM zSeries 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 standard FICON channel can provide up to 120 megabytes per second (MBps) effective bandwidth, compared with 17 MBps for ESCON. A FICON Express channel can provide up to 170 MBps, and a FICON Express2 channel is designed to deliver up to 270 MBps of throughput, depending upon application environment.

## 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 IBM zSeries servers (at the appropriate service level). This enables more reliable and higher bandwidth host-to-host communication than is available with ESCON channels.

## HiperSockets

CP supports the z/Architecture HiperSockets function for high-speed TCP/IP communication among virtual machines and logical partitions (LPARs) within the same IBM zSeries server. 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 TCP/IP for z/VM 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.

## Base Facilities

On the z990 server, 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 on zSeries guests running on z/VM images in different logical partitions, when the z/VM images are using different logical channel subsystems.

### IEEE Floating Point

CP supports guest use of the IEEE Floating Point hardware on IBM zSeries servers. 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.

### Integrated Facility for Linux

The IBM Integrated Facility for Linux (IFL) is a hardware feature available on IBM zSeries servers which provides additional processing capacity for Linux workloads. Implementation of this facility requires an LPAR definition, following normal LPAR activation procedures. Only certain applications can run on an LPAR IFL; see Appendix A, “IBM Servers Supported by z/VM,” on page 87.

### Logical Channel Subsystem

The z990 and z890 servers provide a logical channel subsystem (LCSS) structure, which 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 z990 or z890 server with the applicable hardware support.

### Move-Page Facility

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

### Open Systems Adapter

CP supports guest use of the Open Systems Adapter-2 (OSA-2), Open Systems Adapter-Express (OSA-Express), and Open Systems Adapter-Express2 (OSA-Express2) hardware features of zSeries servers, which provide connectivity to various types of networks.

CP also supports the OSA-Express Integrated Console Controller (OSA-ICC). The OSA-ICC is a function of the OSA-Express 1000BASE-T Ethernet device that integrates 3270 emulation for console session connections into the z990 and z890 servers.

z/VM includes the Open Systems Adapter Support Facility (OSA/SF) for customizing an OSA's modes of operation. For more information, see “Open Systems Adapter Support Facility” on page 58.

### Processor Resource/Systems Manager™

On processors with the Processor Resource/Systems Manager (PR/SM™) feature installed, CP supports only logically partitioned (LPAR) mode. CP does not support basic mode or preferred guests.

**PR/SM Support of Logical Partitioning:** When the processor operates in LPAR mode, it provides flexible partitioning of processor resources across multiple logical partitions. Each logical partition contains some portion of the processor, storage, and channel path resources and, if available, some portion of the processor's expanded storage resources.

CP supports logical path measurement in an ESCON Multiple Image Facility (EMIF) environment.

### 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. On the z990 and z890 servers, adapter interruptions are also used by OSA-Express and FCP channels.

The z990 and z890 can also 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 V=V guests that support QDIO.

---

## Conversational Monitor System

The Conversational Monitor System (CMS) provides a high-capacity environment that supports 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 the *z/VM: CMS User's Guide*.

## Shared File System

The Shared File System (SFS) is an extension of the CMS file system that offers you 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.

## Base Facilities

- Multiple users can have concurrent access to the same file or directory.
- Locks on files and directories ensure data integrity among multiple users.
- You can share files and directories with users in 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 may also provide a performance improvement.

For more information, see *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 VM” on page 61.

## CMS Application Programming

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

- ESA/XC support
- CMS Pipelines
- Callable services library (CSL)
- Multitasking services
- OpenExtensions
- Program Management Binder
- Systems management APIs
- Reusable Server Kernel
- Assembler macros and functions
- OS/MVS simulation
- DOS/VSE support

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

## 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 the *z/VM: CMS Pipelines User's Guide*.

## 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

OpenExtensions 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 commands, known as the 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 the *z/VM: CMS Application Development Guide*.

## Program Management Binder for CMS

The Program Management Binder for CMS (CMS Binder) is a CMS-enabled version of the OS/390® DFSMS Program Management Binder. The CMS Binder converts the output of language translators and compilers into an executable program unit

## Base Facilities

that can either be read directly into virtual storage for execution or stored in a program library. For more information, see *z/VM: Program Management Binder for CMS*.

## Systems Management APIs

The systems management application programming interfaces (APIs) provide a standard, platform-independent client interface that reduces the amount of VM-specific programming skills required to manage resources for virtual systems (guests). The APIs include functions for creating new virtual images, allocating and managing their resources, and changing their configurations. They can be used to activate and deactivate images individually or in groups. Security and directory management functions are also provided.

The APIs are invoked by a client through a set of Remote Procedure Calls (RPCs) that can be called from the C programming language on any platform that supports the Open Network Computing RPC standard. A set of CMS CSL routines provides the actual functionality to the server. These CSL routines are replaceable to allow customized solutions for those who wish to implement their own RPC functions or other applications. A dedicated z/VM server virtual machine manages the RPC-CSL interface. For more information, see *z/VM: Systems Management Application Programming*.

## 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 the *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.

For more information, 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 the *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:

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

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

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## TCP/IP for z/VM

TCP/IP for z/VM brings the power and resources of your IBM zSeries server to the Internet. Using the TCP/IP protocol suite of TCP/IP for z/VM, you can reach open multi-vendor networking environments from your z/VM system. TCP/IP for z/VM allows z/VM systems to act as peers of other central computers in TCP/IP open networks. Applications can be shared transparently across VM, Linux, and other environments. As shown in Figure 1 on page 54, users can send messages, transfer files, share printers, and access remote resources across a broad range of systems from multiple vendors.

TCP/IP for z/VM provides the following types of functions:

- Connectivity and gateway functions, which handle the physical interfaces and routing of data.
- Server functions, which provide a service to a client (that is, send or transfer a file).
- Client functions, which request a certain service from a server anywhere in the network.
- Network status and management functions, which detect and solve network problems.
- Application programming interfaces, which allow you to write your own client/server applications.

## Base Facilities

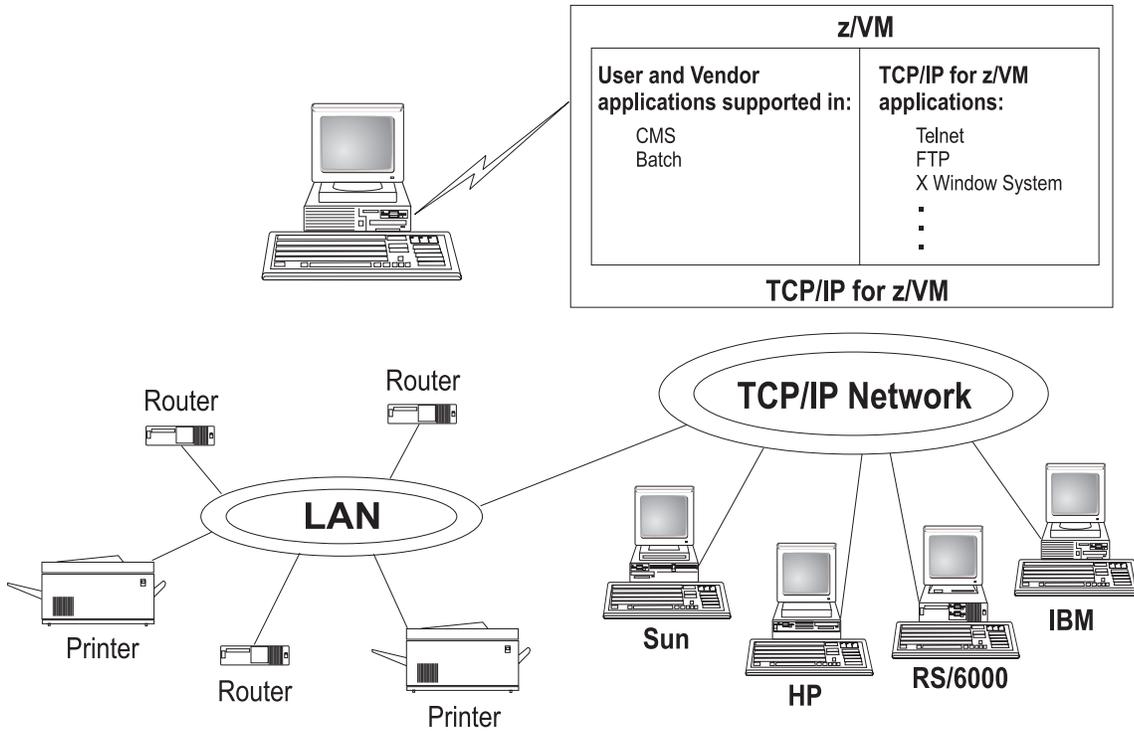


Figure 1. TCP/IP for z/VM as Part of a Multi-Vendor Network

TCP/IP consists of a layered structure of protocols and functions.

## 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. The link protocols include Token-Ring, Ethernet, and X.25.

## 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. Also, the z/VM TCP/IP stack does not support IPv6 security or IPv6 in the upper application layers, such as FTP and SMTP. However, a telnet client that supports IPv6 can connect to the telnet server in the z/VM TCP/IP stack.

## 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 includes the following applications and protocols:

- **Telnet Protocol** provides a standard method to interface terminal devices and terminal-oriented processes with each other.
- **File Transfer Protocol (FTP)** allows you to transfer data between local and foreign hosts or between two foreign hosts.
- **Trivial File Transfer Protocol (TFTP)** reads and writes files to and from a foreign host.
- **Internet Message Access Protocol (IMAP)** provides the processing that allows a client to access electronic mail that is kept in an IMAP Mailstore server.
- **Simple Mail Transfer Protocol (SMTP)** is an electronic mail protocol that is implemented with the CMS NOTE and SENDFILE commands.
- **Domain Name System (DNS)** is a hierarchical-naming system for naming hosts.
- **Simple Network Management Protocol (SNMP)** provides a means for managing an internet environment.
- **Kerberos Authentication System** provides additional security by allowing authorization checking at the user level rather than at the node level.
- **Remote Printing (LPR and LPD)** provides both client and server support for remote printing.
- **RouteD** uses the Routing Information Protocol (RIP) to dynamically create and maintain network routing tables.
- **X Window System** supports network transparent windowing and graphics.
- **X Toolkit** is a collection of basic C language routines for developing a variety of application environments.

## Base Facilities

- **GDDMXD** is an interface that allows graphics from the IBM Graphical Data Display Manager/VM to be displayed on workstations that support the X Window System.
- **Remote Procedure Call (RPC)** is a programming interface that calls subroutines to be executed on a foreign host.
- **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.
- **Bootstrap Protocol (BOOTP)** allows a diskless client machine to discover its own IP address, the address of a server host, and the name of a file to be loaded into memory and executed.
- **Dynamic Host Configuration Protocol (DHCP)** provides a framework for passing configuration information to hosts on a TCPIP network.
- **Network Database System (NDB)** is used to access relational database systems in a TCP/IP-based internet environment.
- **Socket interfaces** allow you to write your own applications to supplement those supplied by TCP/IP.
- **Secure Sockets Layer (SSL)** protocol provides privacy between two communicating applications — a client and a server.

For more information, see the *z/VM: TCP/IP User's Guide*.

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## APPC/VM VTAM Support

APPC/VM VTAM Support (AVS) is a Virtual Telecommunications Access Method (VTAM) application that provides advanced program-to-program communication (APPC) services between VM and non-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 VM systems within the SNA network
- APPC applications residing in non-VM systems in the SNA network

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

---

## 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 standalone 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 45.

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## Group Control System

The Group Control System (GCS) runs in an XA or XC virtual machine in place of CMS. It 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 VS1 or VSE. For more information, see *z/VM: Group Control System*.

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## Hardware Configuration Definition and Hardware Configuration Manager for z/VM

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

z/VM's original dynamic I/O configuration capabilities are still valid. These consist of a set of system operator commands for changing the zSeries 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 zSeries 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:

- *z/VM: I/O Configuration*
- *z/OS and z/VM: Hardware Configuration Manager User's Guide*

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## 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:

## Base Facilities

- 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:

- *z/VM: Language Environment User's Guide*
- *z/OS: Language Environment Concepts Guide*

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## Open Systems Adapter Support Facility

Open Systems Adapter-2 (OSA-2), Open Systems Adapter-Express (OSA-Express), and Open Systems Adapter Express2 (OSA-Express2) are integrated hardware features that allow zSeries platforms to provide industry-standard connectivity directly to clients on local area networks (LANs) and wide area networks (WANs). The Open Systems Adapter Support Facility (OSA/SF) is a host-based tool supplied with z/VM that allows you to customize an OSA's modes of operation. You can access OSA/SF by a CMS user ID, by a REXX call to the OSA/SF API, or through a Java-based graphical user interface (GUI). For more information, see one of the following:

- *eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature*
- *eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*

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## REXX/VM

REXX/VM contains the REXX/VM Interpreter, which processes the English-like Restructured Extended Executor (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 the *z/VM: REXX/VM User's Guide*.

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## Transparent Services Access Facility

The Transparent Services Access Facility (TSAF) provides communication services within a collection of VM systems without using VTAM. TSAF runs in a CMS virtual machine. A group of up to eight VM systems that each have TSAF installed and running can form a TSAF collection. APPC/VM programs on one VM system in the TSAF collection can communicate with other APPC/VM programs on the other 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*.

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## Virtual Machine Serviceability Enhancements Staged/Extended

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*.



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## Chapter 6. z/VM Optional Features

This chapter provides an overview of the optional features of z/VM:

- “Data Facility Storage Management Subsystem for VM”
- “Directory Maintenance Facility”
- “Performance Toolkit for VM” on page 62
- “Resource Access Control Facility for z/VM” on page 63

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### Data Facility Storage Management Subsystem for VM

The Data Facility Storage Management Subsystem for 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-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-managed storage to DFSMS-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 provides native VM support for the IBM 3494 and 3495 Tape Library Dataservers.

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

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### Directory Maintenance Facility

The Directory Maintenance Facility (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, including Cross System Extensions (CSE) cluster directory statements. 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:

## Optional Features

- DirMaint operates as a CMS application. It 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 products, 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 requiring that a password be entered for every user transaction. This is the default.

For more information, see:

- “DirMaint Restrictions” on page 35
- “DirMaint System Integrity” on page 39
- “DirMaint Security” on page 41
- *z/VM: Directory Maintenance Facility Tailoring and Administration Guide*

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## Performance Toolkit for VM

The Performance Toolkit for VM, which is derived from the FCON/ESA program (5788-LGA), 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, the Performance Toolkit processes Linux performance data obtained from the Resource Management Facility (RMF™) Linux performance gatherer, **rmfpms**. The **rmfpms** application is available from the zSeries Web site at [ibm.com/zseries/zos/rmf/rmfhtmls/pmweb/pmlin.htm](http://ibm.com/zseries/zos/rmf/rmfhtmls/pmweb/pmlin.htm).

The Linux performance data obtained from RMF can be viewed and printed in a manner similar to the presentation of VM data.

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

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## Resource Access Control Facility for z/VM

Resource Access Control Facility (RACF) 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

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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 *Resource Access Control Facility: General Information*.

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## Chapter 7. z/VM Library Guide

This chapter provides information about the z/VM product documentation. It contains the following sections:

- “Where to Get z/VM Documentation”
- “Books in the z/VM Base Library” on page 66
- “Books for z/VM Optional Features” on page 78
- “Book Editions and Media” on page 81

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### Where to Get z/VM Documentation

z/VM product documentation is available from several sources, as described in this section.

#### IBM Publications Center

You can obtain z/VM books from the IBM Publications Center, at [www.ibm.com/shop/publications/order/](http://www.ibm.com/shop/publications/order/). The IBM Publications Center is IBM's strategic portal on the Web to make product documentation available to customers. It provides worldwide downloading and ordering facilities for a broad range of IBM product documentation in many languages.

#### z/VM Internet Library

The z/VM Internet Library, at [www.ibm.com/eserver/zseries/zvm/library/](http://www.ibm.com/eserver/zseries/zvm/library/), provides links to various online z/VM information resources, such as:

- **z/VM LibraryCenter**

The z/VM LibraryCenter, at [publibz.boulder.ibm.com/bookmgr\\_OS390/libraryserver/zvmv5r1/](http://publibz.boulder.ibm.com/bookmgr_OS390/libraryserver/zvmv5r1/), provides advanced tools for searching z/VM and related product bookshelves derived from the *IBM eServer zSeries Online Library: z/VM Collection* CD-ROM. You can search individual books or bookshelves, or you can search across the entire z/VM Collection “bookcase”. The books in the z/VM bookshelf have been enabled for filtered searches by command name or message ID. This means that you can search the z/VM bookshelf for a command name or message ID, and the tool will take you directly to the location of the primary reference information. If the command or message ID cannot be found with the filtered search, the search defaults to a standard BookManager search.

- Softcopy bookshelves for supported z/VM releases

These bookshelves contain IBM BookManager-format books, displayed as HTML, and offer standard BookManager book and bookshelf searching capability.

- Adobe Portable Document Format (PDF) libraries for supported z/VM releases
- PDF files for special z/VM publications and recently updated z/VM books that are not included in the bookshelf or PDF library for the current release
- z/VM program directories
- z/VM data areas, control blocks, and monitor records

- **LookAt**

The LookAt Web site, at [www.ibm.com/eserver/zseries/zos/bkserv/lookat/](http://www.ibm.com/eserver/zseries/zos/bkserv/lookat/), provides an online message lookup facility. Just specify a message ID and a product release, and LookAt displays the reference information for that message.

- IBM Redbooks™
- White papers, consultant reports, and performance reports

## Library Guide

- Specification sheets
- Reference guides
- Marketing brochures
- Journals and bulletins
- Libraries for related IBM products

## z/VM Publications CD-ROM

The *IBM eServer zSeries Online Library: z/VM Collection*, SK2T-2067, contains BookManager bookshelves and PDF libraries for current IBM z/VM system products and IBM licensed products that run on z/VM.

### Notes:

1. Only unlicensed books are included.
2. Some products may not have PDF libraries, and some books may not have PDF versions.

The *z/VM Collection* also includes the following programs:

- **IBM Softcopy Reader** allows you to view and search BookManager files and organize BookManager books and bookshelves.
- **IBM Softcopy Librarian** allows you to manage BookManager files in a repository and download BookManager files from the Internet.
- **Softcopy Receiver Tool** allows you to transfer BookManager files from the CD-ROM to the workstation or host.

## Basic (Automatically Shipped) z/VM Documentation

The following documentation is shipped automatically with the z/VM product at no additional cost:

- One copy of the *z/VM Collection* CD-ROM
- One printed copy of each of the following z/VM books:
  - *z/VM: License Information*
  - *z/VM: Guide for Automated Installation and Service*
  - *z/VM: Getting Started with Linux on zSeries*
- A complete set of z/VM HELP files (included in the z/VM System Image)

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## Books in the z/VM Base Library

This section provides abstracts of the books in the z/VM base library. The base library contains books that describe the facilities included in the z/VM base product. The books are listed under the following task categories:

- “System Overview” on page 67
- “Installation and Service” on page 67
- “Planning and Administration” on page 68
- “Customization” on page 70
- “Operation” on page 71
- “Application Programming” on page 71
- “End Use” on page 75
- “Diagnosis” on page 77

**Note:** Within each category, z/VM branded books are listed first, followed by any additional books also included in that category.

The title of each book is followed by its publication number. For current editions and available media, see “Book Editions and Media” on page 81.

## System Overview

The following books provide information to help you decide if z/VM meets the needs of your installation.

### **z/VM: General Information, GC24-6095**

*z/VM: General Information* (this book) provides general information about z/VM. It contains:

- An introduction to z/VM
- An overview of what is new or changed in the current z/VM release
- z/VM hardware and program (software) requirements and other technical information
- Descriptions of the z/VM base facilities and optional features
- A guide to the z/VM product documentation
- Lists of the IBM servers, guest operating systems, and devices supported by current z/VM releases

### **z/VM: Glossary, GC24-6097**

The *z/VM: Glossary* provides definitions of the terms used in z/VM books.

### **z/VM: License Information, GC24-6102**

*z/VM: License Information* provides information on the warranted functions of z/VM, the specified operating environment, and the supplemental terms.

### **z/VM: Migration Guide, GC24-6103**

The *z/VM: Migration Guide* provides information to help system support personnel migrate to the new z/VM release from a previous VM system. It is also intended for application programmers who use VM external interfaces in their programs. The book contains the following information:

- An introduction to migration
- Descriptions of system changes and enhancements that you should be aware of before migrating
- Identification of specific external interfaces that have changed
- Guidance for some migration tasks you might need to perform, such as converting from system definition macros to system configuration files, and migrating your system directory

## Installation and Service

The following books provide information to help you install and maintain a z/VM system.

### **z/VM: Guide for Automated Installation and Service, GC24-6099**

The *z/VM: Guide for Automated Installation and Service* 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 in DASD Dump/Restore (DDR) format on magnetic tape or CD-ROM, or in binary format on DVD. Installation worksheets are included that you can use to plan your installation.

This book also describes automated procedures for installing preventive and corrective service to the z/VM components and the preinstalled z/VM facilities and features. (More detailed service procedures for the z/VM components are provided in the *z/VM: Service Guide*.)

Included with this book are two additional documents that provide streamlined installation and service procedures:

- *z/VM Summary for Automated Installation and Service (Tape/CD-ROM Installation)*
- *z/VM Summary for Automated Installation and Service (DVD Installation)*

### **z/VM: Service Guide, GC24-6117**

The *z/VM: Service Guide* contains step-by-step procedures for receiving and applying service and rebuilding serviced parts of the z/VM components. This book should be used in conjunction with the *z/VM: VMSES/E Introduction and Reference*.

### **z/VM: VMSES/E Introduction and Reference, GC24-6130**

The *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 program products from a more general, less z/VM-specific, point of view than the *z/VM: Guide for Automated Installation and Service* and the *z/VM: Service Guide*. This book discusses the Software Inventory and how you can use it to manage the products on your system. Reference information on the product parameter file, Software Inventory tables, VMSES/E commands, and other related commands is also provided.

## Planning and Administration

The following books provide information to help you make decisions about how to define and manage a z/VM system. Planning is an iterative task in that many of the decisions are made before installation, continually evaluated after installation, and 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, SC24-6074**

*z/VM: CMS File Pool Planning, Administration, and Operation* provides guidance and reference 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 book 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, SC24-6078**

*z/VM: CMS Planning and Administration* describes how to plan for and administer the Conversational Monitor System (CMS) on your z/VM system. It includes information on the following topics:

- 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, SC24-6080**

*z/VM: Connectivity* provides an overview of the z/VM facilities that enable logical connections between systems. This book presents basic connectivity concepts and planning considerations. It describes how to plan and set up real networks (using

OSA-Express and zSeries 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, SC24-6083**

*z/VM: CP Planning and Administration* describes how to plan for and administer the z/VM Control Program (CP). It includes information on the following topics:

- System planning and administration (including the system configuration file)
- User planning and administration (including the user directory)
- Storage planning and administration

### **z/VM: Getting Started with Linux on zSeries, SC24-6096**

*z/VM: Getting Started with Linux on zSeries* describes how to configure and use z/VM functions and facilities for Linux servers running on zSeries processors. This book is designed to help systems personnel (system programmers, administrators, and operators) who have limited knowledge of z/VM, but want to deploy Linux servers on z/VM. The book provides requirements and guidelines to implement during z/VM installation, but primarily assumes you have installed z/VM and are ready to deploy Linux servers in z/VM virtual machines. Topics covered include:

- z/VM basics
- Planning for Linux servers
- Configuring and administering a z/VM system
- Configuring TCP/IP for z/VM
- Creating and cloning Linux virtual machines
- Setting up rudimentary system automation
- Monitoring performance and capacity

### **z/VM: Group Control System, SC24-6098**

*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 book 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, SC24-6100**

*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 of the book describes how to use Hardware Configuration Definition and Hardware Configuration Manager for z/VM (HCD and HCM for z/VM) to manage the hardware and software I/O configuration. HCM is a Windows-based program that provides a graphical user interface. Part 2 of the book describes how to use z/VM dynamic I/O configuration, which is a command interface for modifying the hardware I/O configuration.

### **z/VM: Performance, SC24-6109**

*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.

### **z/VM: Running Guest Operating Systems, SC24-6115**

*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 zSeries*.

### **z/VM: Saved Segments Planning and Administration, SC24-6116**

*z/VM: Saved Segments Planning and Administration* describes how to plan for and administer 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, SC24-6138**

The *z/VM: Secure Configuration Guide* describes the steps necessary to configure z/VM Version 5 Release 1 to conform with the requirements of the Common Criteria controlled access and labeled security protection profiles.

### **z/VM: TCP/IP Planning and Customization, SC24-6125**

*z/VM: TCP/IP Planning and Customization* is intended to help system administrators plan for TCP/IP networks on a z/VM host and customize TCP/IP to their systems.

### **eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature, GA22-7477**

*eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature* provides information to help you plan for, install, and use the Open Systems Adapter-2 (OSA-2) hardware feature on the z900 server.

### **eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference, SA22-7935**

The *eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference* provides step-by-step instructions for setting up and using the Open Systems Adapter Facility (OSA/SF) to configure and manage OSA-Express features on zSeries servers.

### **eServer zSeries: Open Systems Adapter-Express Integrated Console Controller User's Guide, SA22-7990**

The *eServer zSeries: Open Systems Adapter-Express Integrated Console Controller User's Guide* 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 feature that integrates 3270 emulation for console session connections into zSeries servers.

### **z/OS and z/VM: Hardware Configuration Manager User's Guide, SC33-7989**

The *z/OS and z/VM: Hardware Configuration Manager User's Guide* describes how to use the Hardware Configuration Manager (HCM) graphical user interface to create and maintain hardware configuration information.

## Customization

The following book provides information about extending or enhancing a z/VM system.

**z/VM: CP Exit Customization, SC24-6082**

*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, controlling, and calling CP exit points
- Creating, controlling, and overriding CP commands
- Creating, controlling, and overriding DIAGNOSE codes
- Creating, controlling, and using local message repositories
- Dynamically loading into and unloading from CP storage
- Using dynamic CP exits

**Operation**

The following books provide information about how to start, run, and shut down a z/VM system and how to run z/VM virtual machines.

**z/VM: System Operation, SC24-6121**

*z/VM: System Operation* explains how to operate z/VM on an IBM zSeries server. It contains information about system operator tasks, such as:

- Using the Stand-Alone Program Loader
- 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: Virtual Machine Operation, SC24-6128**

*z/VM: Virtual Machine Operation* contains information about operating a z/VM virtual machine. It may be particularly useful for the user who wants to run an operating system in a virtual machine. The book 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

**Application Programming**

The following books provide information about designing, coding, compiling, running, debugging, and maintaining application programs to do specific functions on z/VM.

**z/VM: CMS Application Development Guide, SC24-6069**

The *z/VM: CMS Application Development Guide* provides information about developing an application program in CMS. The development process includes planning, designing, writing, compiling, debugging, executing, and updating. This book 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, SC24-6070**

The *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, SC24-6071**

*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 book provides introductory and tutorial information as well as detailed reference material.

### **z/VM: CMS Callable Services Reference, SC24-6072**

The *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, SC24-6075**

The *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: CP Programming Services, SC24-6084**

*z/VM: CP Programming Services* describes the application programming services and facilities available in CP, including:

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

### **z/VM: CPI Communications User's Guide, SC24-6085**

The *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: Enterprise Systems Architecture/Extended Configuration Principles of Operation, SC24-6094**

The *z/VM: Enterprise Systems Architecture/Extended Configuration 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: Language Environment User's Guide, SC24-6101**

The *z/VM: Language Environment User's Guide* provides information for using Language Environment on z/VM. It describes the differences between using

Language Environment on z/OS and z/VM and points to the z/OS Language Environment documentation for more information.

### **z/VM: OpenExtensions Advanced Application Programming Tools, SC24-6104**

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

### **z/VM: OpenExtensions Callable Services Reference, SC24-6105**

The *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 book also describes callable services that are not related to the standards.

### **z/VM: OpenExtensions Commands Reference, SC24-6106**

The *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, GC24-6107**

The *z/VM: OpenExtensions POSIX Conformance Document* describes the z/VM implementation of those areas of the IEEE POSIX.1 and POSIX.2 standards that were declared to be optional or implementation-defined.

### **z/VM: OpenExtensions User's Guide, SC24-6108**

The *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, SC24-6110**

*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 OS/390 Program Management binder, and this book describes the differences in usage and behavior between the two programs. This book should be used in conjunction with *OS/390: DFSMS Program Management*.

### **z/VM: Reusable Server Kernel Programmer's Guide and Reference, SC24-6112**

The *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 book covers advanced material in server construction and is not intended for beginning programmers.

### **z/VM: REXX/VM Reference, SC24-6113**

The *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, SC24-6114**

The *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, SC24-6122**

*z/VM: Systems Management Application Programming* describes application programming interfaces (APIs) for performing systems management functions for virtual systems (guests) in a z/VM environment. Two sets of APIs are described:

- Remote procedure calls (RPCs), which can be called from C applications on any platform that supports the RPC standard.
- Callable services library (CSL) routines, which are invoked by the RPCs. These CSL routines can also be called directly from CMS applications, and they are replaceable to allow for customization.

### **z/VM: TCP/IP Programmer's Reference, SC24-6126**

The *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 program interfaces (APIs):

- C sockets
- IUCV sockets
- Pascal
- Virtual Machine Communication Facility (VMCF)
- Remote Procedure Calls (RPCs)
- X Window System
- Kerberos Authentication System
- Simple Network Management Protocol (SNMP) agent distributed program interface
- Network Computing System (NCS)
- CMS command interface to the name server
- Simple Mail Transfer Protocol (SMTP)

### **Common Programming Interface Communications Reference, SC26-4399**

The *Common Programming Interface Communications Reference* 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**

The *Common Programming Interface Resource Recovery Reference* describes the System Application Architecture (SAA) Common Programming Interface 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.

### **OS/390: DFSMS Program Management, SC27-0806**

*OS/390: DFSMS Program Management* describes the program management services provided by OS/390 DFSMS. These services include the program management binder, the program management loader, the linkage editor, and the batch loader. This book describes how to use these services to create, modify, execute, and maintain programs.

**z/OS: Language Environment Concepts Guide, SA22-7567**

The *z/OS: Language Environment Concepts Guide* provides information on evaluating and planning for Language Environment.

**z/OS: Language Environment Debugging Guide, GA22-7560**

The *z/OS: Language Environment Debugging Guide* provides assistance in detecting and locating programming errors that may occur during runtime under Language Environment. The book 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, SA22-7561**

The *z/OS: Language Environment Programming Guide* 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, SA22-7562**

The *z/OS: Language Environment Programming Reference* 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, SA22-7566**

The *z/OS: Language Environment Run-Time Messages* contains runtime messages and return codes for Language Environment and supported high-level languages.

**z/OS: Language Environment Writing ILC Applications, SA22-7563**

*z/OS: Language Environment Writing ILC Applications* 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.

**End Use**

The following books describe how to perform various user tasks on z/VM.

**z/VM: CMS Commands and Utilities Reference, SC24-6073**

The *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 Pipelines Reference, SC24-6076**

The *z/VM: CMS Pipelines Reference* provides reference information on the CMS PIPE command and CMS Pipelines stages, subcommands, and assembler macros.

**z/VM: CMS Pipelines User's Guide, SC24-6077**

The *z/VM: CMS Pipelines User's Guide* describes the general concepts of CMS Pipelines and how to use CMS Pipelines, including:

- Writing a pipeline
- Using filters, host command interfaces, and device drivers
- Writing a stage command
- Writing a multi-stream pipeline
- Using pipelines in exec procedures and XEDIT macros
- Storing user-written stage commands in a filter package
- Migrating from CMS Pipelines 1.1.6

### **z/VM: CMS Primer, SC24-6137**

The *z/VM: CMS Primer* provides information on basic CMS tasks and commands. It presents, through examples, only 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, SC24-6079**

The *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 book 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 read the *z/VM: CMS Primer* before reading this book.

### **z/VM: CP Commands and Utilities Reference, SC24-6081**

The *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: Quick Reference, SC24-6111**

The *z/VM: Quick Reference* contains an alphabetical listing of z/VM commands, utilities, and statements. It shows the syntax of each function, indicates the environment and intended user, and identifies the reference book where you can find detailed information. This book also contains a summary of reference information about communicating with z/VM and interpreting its responses.

### **z/VM: TCP/IP User's Guide, SC24-6127**

The *z/VM: TCP/IP User's Guide* is intended for the end user and describes how to use TCP/IP after it has been installed and customized on your network. The book explains how to use the applications available in TCP/IP, including:

- Transferring files
- Sending electronic mail
- Logging on to a foreign host
- Monitoring the network
- Authenticating network users
- Remote printing
- Managing network resources
- Using the Domain Name System

**z/VM: XEDIT Commands and Macros Reference, SC24-6131**

The *z/VM: XEDIT Commands and Macros Reference* provides detailed reference information on the XEDIT command, subcommands, and macros. Users should read the *z/VM: XEDIT User's Guide* before reading this book.

**z/VM: XEDIT User's Guide, SC24-6132**

The *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.

**CMS/TSO Pipelines Author's Edition, SL26-0018**

*CMS/TSO Pipelines Author's Edition* provides information on CMS/TSO Pipelines from its author. (CMS/TSO Pipelines evolved from the CMS Pipelines PRPQ.) In addition to a description of CMS/TSO Pipelines terms and concepts, this book includes reference information on the PIPE command and Pipelines stages, commands, and messages. This book contains additional information not found in the *z/VM: CMS Pipelines Reference* and also provides information intended for the advanced Pipelines user.

## Diagnosis

The following books provide information to help identify, describe, report, and correct a programming problem in a z/VM system.

**z/VM: Diagnosis Guide, GC24-6092**

The *z/VM: Diagnosis Guide* provides diagnostic guidance information to help you identify, report, solve, and collect information about problems that may occur in z/VM.

**z/VM: Dump Viewing Facility, GC24-6093**

*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.

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

**z/VM: System Messages and Codes - AVS, Dump Viewing Facility, GCS, TSAF, and VMSES/E, GC24-6120**

*z/VM: System Messages and Codes - AVS, Dump Viewing Facility, GCS, TSAF, and VMSES/E* 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.

**z/VM: System Messages and Codes - CMS and REXX/VM, GC24-6118**

*z/VM: System Messages and Codes - CMS and REXX/VM* 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: System Messages and Codes - CP, GC24-6119**

*z/VM: System Messages and Codes - CP* 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: TCP/IP Diagnosis Guide, GC24-6123**

The *z/VM: TCP/IP Diagnosis Guide* is intended for system programmers who want to diagnose and report problems that may occur in TCP/IP networks.

### **z/VM: TCP/IP Messages and Codes, GC24-6124**

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

### **z/VM: VM Dump Tool, GC24-6129**

*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 utility. The tool can process CP standalone dumps, CP ABEND dumps, and virtual machine dumps of a CP system. This book 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, SC33-7986**

*z/OS and z/VM: Hardware Configuration Definition Messages* provides explanations of the messages issued by Hardware Configuration Definition (HCD).

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## Books for z/VM Optional Features

This section provides abstracts of the books that describe the z/VM optional features. The title of each book is followed by its publication number. For current editions and available media, see “Book Editions and Media” on page 81.

## DFSMS/VM

### **z/VM: DFSMS/VM Customization, SC24-6086**

*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, GC24-6087**

The *z/VM: DFSMS/VM Diagnosis Guide* provides information about diagnosing and reporting DFSMS/VM errors.

### **z/VM: DFSMS/VM Messages and Codes, GC24-6088**

*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, SC24-6089**

The *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, SC24-6090**

*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, SC24-6091**

*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.

## DirMaint

### **z/VM: Directory Maintenance Facility Commands Reference, SC24-6133**

The *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 book also describes the additional utilities that DirMaint provides for minidisk management and command security.

### **z/VM: Directory Maintenance Facility Messages, GC24-6134**

*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, SC24-6135**

The *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 VM

### **z/VM: Performance Toolkit, SC24-6136**

*z/VM: Performance Toolkit* describes how this program can assist system operators and systems programmers or analysts in the following areas:

- **System operator console operation in full screen mode.** Features have been 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. Features included in the monitor, and the manner in which data is displayed, have both been designed to improve the systems programmer's productivity when analyzing the system, and to allow even a new user to work

efficiently with the tool. The program can help systems programmers to make more efficient use of system resources, increase system productivity and improve end-user satisfaction.

## RACF for z/VM

### **External Security Interface (RACROUTE) Macro Reference for MVS and VM, GC28-1366**

The *External Security Interface (RACROUTE) Macro Reference for MVS and VM* describes the interface that MVS™ and VM provide to an external security manager (ESM). This information is intended for programmers who are writing applications that need to invoke RACF (or another ESM) from MVS or VM, or for programmers who are writing an ESM for MVS or VM.

### **Resource Access Control Facility: Auditor's Guide, SC28-1342**

The *Resource Access Control Facility: 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.

### **Resource Access Control Facility: Command Language Reference, SC28-0733**

The *Resource Access Control Facility: Command Language Reference* describes the syntax and functions of RACF commands.

### **Resource Access Control Facility: Diagnosis Guide, GY28-1016**

The *Resource Access Control Facility: Diagnosis Guide* explains how to diagnose problems that may occur in RACF.

### **Resource Access Control Facility: General Information, GC28-0722**

*Resource Access Control Facility: General Information* contains an overview of RACF and highlights the latest enhancements.

### **Resource Access Control Facility: General User's Guide, SC28-1341**

The *Resource Access Control Facility: 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.

### **Resource Access Control Facility: Macros and Interfaces, SC28-1345**

*Resource Access Control Facility: 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'. This book does not document the RACROUTE macro or the independent RACF system macros, which are documented in the *External Security Interface (RACROUTE) Macro Reference for MVS and VM*.

### **Resource Access Control Facility: Messages and Codes, SC38-1014**

*Resource Access Control Facility: Messages and Codes* describes RACF messages, abend codes, manager return codes, and utility return codes.

### Resource Access Control Facility: Migration and Planning, GC23-3054

*Resource Access Control Facility: Migration and Planning* provides information to guide installations through the migration process from RACF 1.9.2 for VM to RACF 1.10.0 for VM. This book is not intended for customers installing RACF for the first time.

### Resource Access Control Facility: Security Administrator's Guide, SC28-1340

The *Resource Access Control Facility: 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

### Resource Access Control Facility: System Programmer's Guide, SC28-1343

The *Resource Access Control Facility: 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

## Book Editions and Media

This section identifies the current edition and available media for each book in the z/VM library. Table 2 on page 82 lists the books for the z/VM base facilities. Table 3 on page 84 lists the books for the z/VM optional features.

The following notations are used in the tables:

- NEW** indicates that the book is either completely new or is a new addition to the z/VM library.
- ✓ indicates that the book has been updated with a new edition since the previous z/VM release. Updates may be major or minor. If the book is not exclusive to z/VM, the updates might not be z/VM-related. Refer to the book's Summary of Changes.
- ★ indicates that the book has been updated with a new edition to support programming enhancements to z/VM V5R1. Refer to the book's Summary of Changes.
- \*
- SC** indicates that softcopy (PDF and BookManager) versions of the book are provided on the *IBM eServer zSeries Online Library: z/VM Collection* CD-ROM supplied with z/VM. These softcopy books are also available from the IBM Publications Center and the z/VM Internet Library.
- HC** indicates that a hard copy (printed) version of the book is available, but it must be ordered from the IBM Publications Center for a fee.

## Library Guide

### Notes:

1. The current edition of the *z/VM Collection* CD-ROM is SK2T-2067-22.  
This edition of the CD-ROM does not include updated editions of z/VM V5R1 books (marked with ★ in the table), but provides the z/VM V5R1 base editions of those books. You can obtain the updated editions from the IBM Publications Center or the z/VM Internet Library.
2. BookManager files are primarily intended for online viewing and searching. They are not intended for printing, although some programs may provide that function. If you attempt to print BookManager files, you may encounter unexpected results or error conditions. Use the PDF version of a book for printing.

## z/VM Base Library

The following table shows the current edition and available media for each book in the z/VM base library.

**Note:** z/VM books are listed first, followed by additional books also included in the base library.

Table 2. Current Edition and Available Media for Books in the z/VM Base Library

Book Title	Number	Updated	Media
z/VM: CMS Application Development Guide	SC24-6069-00	✓	SC
z/VM: CMS Application Development Guide for Assembler	SC24-6070-00	✓	SC
z/VM: CMS Application Multitasking	SC24-6071-00	✓	SC
z/VM: CMS Callable Services Reference	SC24-6072-00	✓	SC
z/VM: CMS Commands and Utilities Reference	SC24-6073-00	✓	SC
z/VM: CMS File Pool Planning, Administration, and Operation	SC24-6074-00	✓	SC
z/VM: CMS Macros and Functions Reference	SC24-6075-00	✓	SC
z/VM: CMS Pipelines Reference	SC24-6076-00	✓	SC
z/VM: CMS Pipelines User's Guide	SC24-6077-00	✓	SC
z/VM: CMS Planning and Administration	SC24-6078-00	✓	SC
z/VM: CMS Primer	SC24-6137-00	✓	SC HC
z/VM: CMS User's Guide	SC24-6079-00	✓	SC
z/VM: Connectivity	SC24-6080-01	✓ ★	SC
z/VM: CP Commands and Utilities Reference	SC24-6081-01	✓ ★	SC
z/VM: CP Exit Customization	SC24-6082-00	✓	SC
z/VM: CP Planning and Administration	SC24-6083-01	✓ ★	SC
z/VM: CP Programming Services	SC24-6084-00	✓	SC
z/VM: CPI Communications User's Guide	SC24-6085-00	✓	SC
z/VM: Diagnosis Guide	GC24-6092-00	✓	SC
z/VM: Dump Viewing Facility	GC24-6093-00	✓	SC
z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation	SC24-6094-00	✓	SC
z/VM: General Information	GC24-6095-02	✓ ★	SC
z/VM: Getting Started with Linux on zSeries	SC24-6096-00	NEW	* SC <sup>1</sup>
z/VM: Glossary	GC24-6097-00	✓	SC

Table 2. Current Edition and Available Media for Books in the z/VM Base Library (continued)

Book Title	Number	Updated	Media
z/VM: Group Control System	SC24-6098-00	✓	SC
z/VM: Guide for Automated Installation and Service	GC24-6099-01	✓★	* SC <sup>1, 2</sup>
z/VM: I/O Configuration	SC24-6100-00	✓	SC
z/VM: Language Environment User's Guide	SC24-6101-00	✓	SC
z/VM: License Information	GC24-6102-00	✓	* SC <sup>2</sup>
z/VM: Migration Guide	GC24-6103-01	✓★	SC
z/VM: OpenExtensions Advanced Application Programming Tools	SC24-6104-00	✓	SC
z/VM: OpenExtensions Callable Services Reference	SC24-6105-00	✓	SC
z/VM: OpenExtensions Commands Reference	SC24-6106-00	✓	SC
z/VM: OpenExtensions POSIX Conformance Document	GC24-6107-00	✓	SC
z/VM: OpenExtensions User's Guide	SC24-6108-00	✓	SC
z/VM: Performance	SC24-6109-00	✓	SC
z/VM: Program Management Binder for CMS	SC24-6110-00	✓	SC
z/VM: Quick Reference	SC24-6111-00	✓	SC
z/VM: Reusable Server Kernel Programmer's Guide and Reference	SC24-6112-00	✓	SC
z/VM: REXX/VM Reference	SC24-6113-00	✓	SC
z/VM: REXX/VM User's Guide	SC24-6114-00	✓	SC
z/VM: Running Guest Operating Systems	SC24-6115-00	✓	SC
z/VM: Saved Segments Planning and Administration	SC24-6116-00	✓	SC
z/VM: Secure Configuration Guide	SC24-6138-00	NEW	SC <sup>1</sup>
z/VM: Service Guide	GC24-6117-00	✓	SC
z/VM: System Messages and Codes - AVS, Dump Viewing Facility, GCS, TSAF, and VMSES/E	GC24-6120-00	✓	SC
z/VM: System Messages and Codes - CMS and REXX/VM	GC24-6118-00	✓	SC
z/VM: System Messages and Codes - CP	GC24-6119-01	✓★	SC
z/VM: System Operation	SC24-6121-00	✓	SC
z/VM: Systems Management Application Programming	SC24-6122-00	✓	SC
z/VM: TCP/IP Diagnosis Guide	GC24-6123-00	✓	SC
z/VM: TCP/IP Messages and Codes	GC24-6124-00	✓	SC
z/VM: TCP/IP Planning and Customization	SC24-6125-00	✓	SC HC
z/VM: TCP/IP Programmer's Reference	SC24-6126-00	✓	SC
z/VM: TCP/IP User's Guide	SC24-6127-00	✓	SC
z/VM: Virtual Machine Operation	SC24-6128-00	✓	SC
z/VM: VM Dump Tool	GC24-6129-00	✓	SC
z/VM: VMSES/E Introduction and Reference	GC24-6130-00	✓	SC
z/VM: XEDIT Commands and Macros Reference	SC24-6131-00	✓	SC
z/VM: XEDIT User's Guide	SC24-6132-00	✓	SC
CMS/TSO Pipelines Author's Edition	SL26-0018-03		SC <sup>3</sup> HC
Common Programming Interface Communications Reference	SC26-4399-09 <sup>4</sup>		SC <sup>3</sup> HC

## Library Guide

Table 2. Current Edition and Available Media for Books in the z/VM Base Library (continued)

Book Title	Number	Updated	Media
Common Programming Interface Resource Recovery Reference	SC31-6821-01		SC <sup>3</sup> HC
eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature	GA22-7477-00		SC
eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference	SA22-7935-03	✓	SC
eServer zSeries: Open Systems Adapter-Express Integrated Console Controller User's Guide	SA22-7990-00	NEW	SC
OS/390: DFSMS Program Management	SC27-0806-00		SC HC
z/OS: Language Environment Concepts Guide	SA22-7567-04	✓	SC
z/OS: Language Environment Debugging Guide	GA22-7560-04	✓	SC
z/OS: Language Environment Programming Guide	SA22-7561-04	✓	SC
z/OS: Language Environment Programming Reference	SA22-7562-04	✓	SC
z/OS: Language Environment Run-Time Messages	SA22-7566-04	✓	SC
z/OS: Language Environment Writing ILC Applications	SA22-7563-02	✓	SC
z/OS and z/VM: Hardware Configuration Definition Messages	SC33-7986-05	✓	SC
z/OS and z/VM: Hardware Configuration Manager User's Guide	SC33-7989-05	✓	SC
<b>Notes on the z/VM Base Library:</b>			
1. Not included on the <i>z/VM Collection</i> CD-ROM.			
2. Not available in BookManager format.			
3. Not available in a PDF version.			
4. The latest BookManager version of the <i>Common Programming Interface Communications Reference</i> is SC26-4399-08.			

## z/VM Optional Features

The following table shows the current edition and available media for each book provided for the z/VM optional features.

Table 3. Current Edition and Available Media for Books for z/VM Optional Features

Feature / Book Title	Number	Updated	Media
<b>DFSMS/VM</b>			
z/VM: DFSMS/VM Customization	SC24-6086-00	✓	SC
z/VM: DFSMS/VM Diagnosis Guide	GC24-6087-00	✓	SC
z/VM: DFSMS/VM Messages and Codes	GC24-6088-00	✓	SC
z/VM: DFSMS/VM Planning Guide	SC24-6089-00	✓	SC
z/VM: DFSMS/VM Removable Media Services	SC24-6090-00	✓	SC
z/VM: DFSMS/VM Storage Administration	SC24-6091-00	✓	SC
<b>DirMaint</b>			
z/VM: Directory Maintenance Facility Commands Reference	SC24-6133-00	✓	SC
z/VM: Directory Maintenance Facility Messages	GC24-6134-00	✓	SC
z/VM: Directory Maintenance Facility Tailoring and Administration Guide	SC24-6135-00	✓	SC
<b>Performance Toolkit for VM</b>			
z/VM: Performance Toolkit	SC24-6136-01	✓ ★	SC

Table 3. Current Edition and Available Media for Books for z/VM Optional Features (continued)

Feature / Book Title	Number	Updated	Media
<b>RACF for z/VM</b>			
External Security Interface (RACROUTE) Macro Reference for MVS and VM	GC28-1366-09		<b>SC</b>
Resource Access Control Facility: Auditor's Guide	SC28-1342-13		<b>SC</b>
Resource Access Control Facility: Command Language Reference	SC28-0733-18	✓	<b>SC</b>
Resource Access Control Facility: Diagnosis Guide	GY28-1016-08		<b>SC</b>
Resource Access Control Facility: General Information	GC28-0722-19		<b>SC</b>
Resource Access Control Facility: General User's Guide	SC28-1341-10		<b>SC</b>
Resource Access Control Facility: Macros and Interfaces	SC28-1345-09	✓	<b>SC</b>
Resource Access Control Facility: Messages and Codes	SC38-1014-18		<b>SC</b>
Resource Access Control Facility: Migration and Planning	GC23-3054-05		<b>SC</b>
Resource Access Control Facility: Security Administrator's Guide	SC28-1340-14	✓	<b>SC</b>
Resource Access Control Facility: System Programmer's Guide	SC28-1343-12		<b>SC</b>



## Appendix A. IBM Servers Supported by z/VM

This appendix provides information about the IBM servers supported by **current** z/VM operating systems. It addresses z/VM operating systems running first level on the hardware or in a logical partition (LPAR). For guest considerations, see Appendix B, “IBM Operating Systems Supported as Guests of z/VM,” on page 91.

The following terms are used in the server support matrix:

Term	Meaning
<b>PR/SM</b>	<b>Processor Resource/Systems Manager.</b> A hardware feature that supports LPAR mode and MPG capability.
<b>LPAR</b>	<b>Logically Partitioned</b> or <b>Logical Partition.</b> On a server with PR/SM operating in logically partitioned (LPAR) mode, server resources are divided across up to 30 logical partitions (LPARs), depending on the server model.
<b>IFL</b>	<b>IBM Integrated Facility for Linux.</b> A hardware feature that provides additional processing capacity for Linux workloads in an LPAR.
<b>MPG</b>	<b>Multiple Preferred Guests.</b> On a server with PR/SM operating in basic mode, a z/VM host operating system supports up to six preferred (high performance) guests.  <b>Note:</b> z/VM V5R1 does not support preferred guests.
<b>VM Data Spaces</b>	A z/VM facility that allows an XC virtual machine to access as many as 1022 data spaces of 2 GB (gigabytes) each.

The following general notes apply to the matrix:

- z/VM can exploit the ESCON Multiple Image Facility (EMIF) when running in an LPAR.
- The inclusion of a server in this matrix does not imply the server is available in all countries.
- For specific service levels required, contact your IBM representative.
- For clarity within the matrix, z/VM releases are indicated using an all-numeric dotted notation. For example, z/VM V5R1 = z/VM 5.1.0.

Table 4. z/VM Server Support Matrix

Server	Mode	Current z/VM Support
<b>P/390, R390</b>	Basic	z/VM 3.1.0
<b>@server xSeries® 430 Enabled for S/390® (x/EFS)</b>	Basic	z/VM 3.1.0
<b>S/390 Multiprise 2000</b>	Basic	z/VM 3.1.0
	LPAR	z/VM 3.1.0

## Server Support

Table 4. z/VM Server Support Matrix (continued)

Server	Mode	Current z/VM Support
<b>S/390 Multiprise 3000 Enterprise Server</b>	Basic	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0 (2)
	LPAR	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0 (2)
	LPAR IFL (1)	z/VM 4.3.0, z/VM 4.4.0 (2)
<b>Notes on Multiprise 3000:</b>		
(1) Only the following run in LPAR IFL mode on this server: Linux on S/390, z/VM 4.3.0, z/VM 4.4.0, and CMS and standalone utilities supplied with those z/VM releases. For ICKDSF support information, see the ICKDSF Program Directory.		
(2) This server does not support using the integrated 3270 console task on the Hardware Management Console as a system operator console for z/VM 4.4.0.		
<b>9672 Parallel Enterprise Server R2/R3</b>	Basic	z/VM 3.1.0
	LPAR	z/VM 3.1.0
<b>9672 Parallel Enterprise Server Generation 3 (G3)</b>	Basic	z/VM 3.1.0 (1)
	LPAR	z/VM 3.1.0 (1)
<b>Notes on G3:</b>		
(1) The CMOS Cryptographic Processor is supported for use by guests.		
<b>9672 Parallel Enterprise Server Generation 4 (G4)</b>	Basic	z/VM 3.1.0 (1,2)
	LPAR	z/VM 3.1.0 (1,2)
<b>Notes on G4:</b>		
(1) 370-mode operating systems will not run as guests of z/VM on this server.		
(2) The CMOS Cryptographic Processor is supported for use by guests.		
<b>9672 Parallel Enterprise Server Generation 5 (G5)</b>	Basic	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5)
	LPAR	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5)
	LPAR IFL (3)	z/VM 4.3.0 (4), z/VM 4.4.0 (4,5)
<b>Notes on G5:</b>		
(1) 370-mode operating systems will not run as guests of z/VM on this server.		
(2) The CMOS Cryptographic Processor is supported for use by guests.		
(3) Only the following run in LPAR IFL mode on this server: Linux on S/390, z/VM 4.3.0, z/VM 4.4.0, and CMS and standalone utilities supplied with those z/VM releases. For ICKDSF support information, see the ICKDSF Program Directory.		
(4) The PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux on S/390 guests. APAR VM62933 is required for DirMaint support.		
(5) To use the integrated 3270 console task on the Hardware Management Console as a system operator console for z/VM 4.4.0, the server must be running at the current Licensed Internal Code (LIC) level with the Hardware Management Console at Version code 1.8.0 or later.		
<b>9672 Parallel Enterprise Server Generation 6 (G6)</b>	Basic	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5)
	LPAR	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5)
	LPAR IFL (3)	z/VM 4.3.0 (4), z/VM 4.4.0 (4,5)

Table 4. z/VM Server Support Matrix (continued)

Server	Mode	Current z/VM Support
<b>Notes on G6:</b>		
(1)	370-mode operating systems will not run as guests of z/VM on this server.	
(2)	The CMOS Cryptographic Processor is supported for use by guests.	
(3)	Only the following run in LPAR IFL mode on this server: Linux on S/390, z/VM 4.3.0, z/VM 4.4.0, and CMS and standalone utilities supplied with those z/VM releases. For ICKDSF support information, see the ICKDSF Program Directory.	
(4)	The PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux on S/390 guests. APAR VM62933 is required for DirMaint support.	
(5)	To use the integrated 3270 console task on the Hardware Management Console as a system operator console for z/VM 4.4.0, the server must be running at the current Licensed Internal Code (LIC) level with the Hardware Management Console at Version code 1.8.0 or later.	
@server zSeries 800 (z800)	Basic	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5), z/VM 5.1.0 (1,2,4,5)
	LPAR	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5), z/VM 5.1.0 (1,2,4,5)
	LPAR IFL (3)	z/VM 4.3.0 (4), z/VM 4.4.0 (4,5), z/VM 5.1.0 (4,5)
@server zSeries 900 (z900)	Basic	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5), z/VM 5.1.0 (1,2,4,5)
	LPAR	z/VM 3.1.0 (1,2), z/VM 4.3.0 (1,2,4), z/VM 4.4.0 (1,2,4,5), z/VM 5.1.0 (1,2,4,5)
	LPAR IFL (3)	z/VM 4.3.0 (4), z/VM 4.4.0 (4,5), z/VM 5.1.0 (4,5)
@server zSeries 890 (z890)	LPAR	z/VM 3.1.0 (1,2,6), z/VM 4.3.0 (1,2,4,6), z/VM 4.4.0 (1,2,4,5), z/VM 5.1.0 (1,2,4,5,7)
	LPAR IFL (3)	z/VM 4.3.0 (4,6), z/VM 4.4.0 (4,5), z/VM 5.1.0 (4,5,7)
@server zSeries 990 (z990)	LPAR	z/VM 3.1.0 (1,2,6), z/VM 4.3.0 (1,2,4,6), z/VM 4.4.0 (1,2,4,5), z/VM 5.1.0 (1,2,4,5,7)
	LPAR IFL (3)	z/VM 4.3.0 (4,6), z/VM 4.4.0 (4,5), z/VM 5.1.0 (4,5,7)

## Server Support

Table 4. z/VM Server Support Matrix (continued)

Server	Mode	Current z/VM Support
<b>Notes on zSeries:</b>		
(1)		370-mode operating systems will not run as guests of z/VM on this server.
(2)		The CMOS Cryptographic Processor is supported for use by guests.
(3)		Only the following run in LPAR IFL mode on this server: Linux on zSeries, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0, and CMS and standalone utilities supplied with those z/VM releases. For ICKDSF support information, see the ICKDSF Program Directory.
(4)		The PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux on zSeries guests. On z/VM 4.3.0 or z/VM 4.4.0, APAR VM62933 is required for DirMaint support.
(5)		To use the integrated 3270 console task on the Hardware Management Console as a system operator console for z/VM 4.4.0 or z/VM 5.1.0, the server must be running at the current Licensed Internal Code (LIC) level with the Hardware Management Console at Version code 1.8.0 or later.
(6)		<p>On z/VM 3.1.0 or z/VM 4.3.0, compatibility support for the z990 and z890 does not provide exploitation of the following z990 and z890 features:</p> <ul style="list-style-type: none"> <li>• Dynamic-I/O configuration in a multiple LCSS environment</li> <li>• More than 15 LPARs</li> <li>• Extended I/O-measurement facilities</li> <li>• IPL from FCP-attached disks</li> <li>• Adapter interruptions for OSA-Express and FCP channels</li> <li>• Performance assist for V=V guests in Linux and z/VM environments</li> </ul> <p>Dynamic-I/O configuration with a z990 or z890 is supported for LCSS0 only.</p> <p>Refer to the z/VM subset of the 2084DEVICE Preventative Service Planning (PSP) bucket prior to installing a z990 server, or the 2086DEVICE PSP bucket prior to installing a z890.</p>
(7)		The PCIX Cryptographic Coprocessor (Crypto Express) and Crypto Express2 are supported for use by Linux and z/OS guests.

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## Appendix B. IBM Operating Systems Supported as Guests of z/VM

This appendix provides information about the IBM operating systems supported as guests of **current** z/VM releases.

In general, a version or release of an operating system is supported as a guest of z/VM only on servers for which support has been announced for that operating system version or release to run native, in an LPAR, or as a guest of z/VM. For example, if an operating system is not supported to run in an LPAR IFL, that operating system is not supported as a guest of z/VM running in an LPAR IFL.

This appendix 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 87.

z/VM may be run in a logical partition (LPAR), which offers production-level performance for V=V workloads, including a mix of CMS and full-function operating systems. An operating system running as a V=V guest of a z/VM image running in an LPAR will experience performance comparable to running as a guest of a z/VM system running natively. Several hardware assists available to z/VM running native are not available to z/VM in an LPAR.

### Notes:

1. When z/VM V3R1, z/VM V4R3, or z/VM V4R4 is run in an LPAR, V=F guests are not supported and I/O passthrough is not available to the V=R guest. For more details, consult the *PR/SM Planning Guide*, GA22-7123, and documentation for the applicable server.
2. z/VM Version 5 does not support V=R or V=F guests.

Running z/VM in a virtual machine (that is, z/VM as a guest of z/VM, also known as “second-level” z/VM) 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, and IBM will not accept performance PMRs against such environments.

The following symbols and abbreviations are used in the “Support” column of the matrix to indicate the level of support:

Symbol	Meaning
—	Guest is not supported
V	Guest is supported in V=V virtual machine
R	Either of the following: <ol style="list-style-type: none"><li>1. Guest is supported in V=R virtual machine</li><li>2. Guest is supported in V=F virtual machine if the server has the PR/SM feature installed</li></ol>
U	Guest may be UP (uniprocessor)
M	Guest may be MP (multiprocessor)
XA	Guest runs in an XA virtual machine
ESA	Guest runs in an ESA virtual machine

## Guest Support

If a guest is supported in both XA and ESA virtual machines, ESA is preferred.

**Note:** For clarity within the matrix, z/VM releases are indicated using an all-numeric dotted notation. For example, z/VM V5R1 = z/VM 5.1.0.

Table 5. z/VM Guest Support Matrix

Guest	Host	Support
<b>Linux on S/390</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (1) VR UM ESA VR UM ESA V UM ESA
<b>Notes for Linux on S/390 Guests:</b>		
(1) The z/VM host must be running on one of the following: IBM S/390 Multiprise 2000, IBM S/390 Multiprise 3000 Enterprise Server, IBM Parallel Enterprise Server R2/R3, IBM S/390 Parallel Enterprise Server™ G3 or later, or IBM zSeries.		
<b>Linux on zSeries</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (1) VR UM ESA (1) VR UM ESA (1) V UM ESA
<b>Notes for Linux on zSeries Guests:</b>		
(1) The z/VM host must be running on an IBM zSeries and the 64-bit CP image must be loaded.		
<b>TPF V4 (1)</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM XA ESA VR UM XA ESA VR UM XA ESA V UM XA ESA
<b>Notes for TPF Guests:</b>		
(1) TPF is supported as a guest of z/VM in environments where TPF-specific server and DASD control unit RPQs are not required. If in a V=V virtual machine, use of Emulation Program for 37xx communication controllers is not supported.		
<b>VSE/ESA™ V2</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM XA ESA VR UM XA ESA VR UM XA ESA V UM XA ESA
<b>z/OS V1 (1)</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (2,3,4) VR UM ESA (3,4) VR UM ESA (3,4) V UM ESA (4)
<b>Notes for z/OS Guests:</b>		
(1) Exploitation of hardware function by z/OS may require specific levels of z/VM. For details, see <i>z/OS and z/OS.e: Planning for Installation</i> , GA22-7504.		
(2) The z/VM 3.1.0 host must be running on an IBM S/390 Multiprise 3000 Enterprise Server, IBM S/390 Parallel Enterprise Server G5 or G6, or IBM zSeries.		
(3) On an IBM S/390 Multiprise 3000 Enterprise Server or IBM S/390 Parallel Enterprise Server G5 or G6, the z/OS guest runs only in 31-bit mode. On an IBM zSeries, the z/OS guest must run in 64-bit mode on a 64-bit CP image.		
(4) z/VM does not support external coupling facilities or real coupling links.		
<b>z/OS.e V1 (1)</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (2,4) VR UM ESA (2,4) VR UM ESA (2,4) V UM ESA (3,4)

Table 5. z/VM Guest Support Matrix (continued)

Guest	Host	Support
<b>Notes for z/OS.e Guests:</b>		
(1) Exploitation of hardware function by z/OS.e may require specific levels of z/VM. For details, see <i>z/OS and z/OS.e: Planning for Installation</i> , GA22-7504.		
(2) The z/VM host must be running the 64-bit CP image on an IBM zSeries 890 or zSeries 800.		
(3) The z/VM host must be running on an IBM zSeries 890 or zSeries 800.		
(4) z/VM does not support external coupling facilities or real coupling links.		
<b>z/VM 3.1.0</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3) V UM ESA (2)
<b>z/VM 4.3.0</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3) V UM ESA (2)
<b>z/VM 4.4.0</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3) V UM ESA (2)
<b>z/VM 5.1.0</b>	z/VM 3.1.0 z/VM 4.3.0 z/VM 4.4.0 z/VM 5.1.0	VR UM ESA (1,2,4) VR UM ESA (1,2,4) VR UM ESA (1,2,4) V UM ESA (2)
<b>Notes for z/VM Guests:</b>		
(1) V=R recovery is not supported for a V=R guest.		
(2) z/VM Guest Coupling Simulation will not work in the z/VM guest.		
(3) The z/VM guest can run in 64-bit mode only when the z/VM host is running a 64-bit CP image on an IBM zSeries.		
(4) The z/VM host must be running a 64-bit CP image on an IBM zSeries.		



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## Appendix C. IBM Devices Supported by z/VM

This appendix provides information about the IBM devices supported by **current** z/VM operating systems.

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 may be supported; consult device announcements and publications for this information.

Device support might not be in the base release of any system shown, but may have been delivered through the service stream by 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 guest operating systems or applications in virtual machines to use the device. There are usually no restrictions on the use of the device by a virtual machine operating system 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 guest operating systems or applications in virtual machines to use the device. The guest or virtual machine application is completely responsible for the management and use of the device. Usage restrictions may 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 may 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 may 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 may apply. There may be exceptions to supported devices and releases depending on your specific configuration. See the CP planning book for your release and hardware announcements for additional information.

It is sometimes possible to define a device differently depending on whether the definition is done using the system configuration file (or HCPRIO) or dynamic I/O configuration support. For instance, a 3725 Communications Controller would be defined as a 3705 Communications Controller using the system configuration file (or HCPRIO) but as a 3725 Communications Controller using dynamic I/O configuration. For specific details about the system configuration file and HCPRIO,

## Device Support

see *z/VM: CP Planning and Administration*. For specific details about dynamic I/O configuration, see *z/VM: I/O Configuration*.

### Notes:

1. z/VM does not support 7-track tapes.
2. For clarity within the matrix, z/VM releases are indicated using an all-numeric dotted notation. For example, z/VM V5R1 = z/VM 5.1.0.

## Direct Access Storage Devices (DASD)

Table 6. Device Support List—DASD

Device	z/VM Releases Providing Support	Support Notes
3370 Model A01, B01, A02, B02	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
3375 Model A1, B1, D1	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
3380 Model A04, AA4, B04, AD4, BD4, AE4, BE4, AJ4, BJ4, AK4, BK4	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for installation of z/VM 4.3.0 or 4.4.0.
3380 Model CJ2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for installation of z/VM 4.3.0 or 4.4.0.
3390 Model A14, A18, B14, B18, B1C, A24, A28, B24, B28, B2C	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Supported in 3390 mode (native mode) with VSE/VSAM 2.1.0 or later.  Mixed 3390 models are not supported for installation of z/VM 4.3.0 or later.  Not supported for installation of z/VM 5.1.0.
3390 Model A34, A38, B34, B38, B3C	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Supported in 3390 mode (native mode) with VSE/VSAM 2.1.0 or later.  Mixed 3390 models are not supported for installation of z/VM 4.3.0 or later.
3390 Model A94, A98, B94, B98, B9C	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Not supported for installation of z/VM 3.1.0, 4.3.0, or 4.4.0.  Although installation of z/VM 5.1.0 to this device is supported, it is not recommended.  3380 Track Compatibility Mode is not supported. Minidisks used with VSE/VSAM or CMS/VSAM are limited to 65,536 tracks (4369 cylinders).  Intended as a mass-storage device. Should not be used for system data or for data for applications that require high performance DASD.
3995 Model 131, 132 Optical Library Dataserver	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Must be dedicated to a guest as a 3088.  Not supported for z/VM installation.

Table 6. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
3995 Model 151, 111 Optical Library Dataserver	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	<p>Must be defined as a 3390.</p> <p>Not supported for z/VM installation.</p> <p>Intended as a mass-storage device. Should not be used for system data or for data for applications that require high performance DASD.</p>
3995 Model 153, 113 Optical Library Dataserver	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	<p>Must be defined as a 3390.</p> <p>Not supported for z/VM installation.</p> <p>Intended as a mass-storage device. Should not be used for system data or for data for applications that require high performance DASD.</p>
9332 Model 400, 402, 600, 602	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
9335 Model B01	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
9336 Model 010, 020, 025	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for installation of z/VM 4.3.0 or z/VM 4.4.0.
9340 Direct Access Storage Subsystem: 9345 Model B12, B22	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
RAMAC Array DASD: 9391 Model A10 Rack with 9392 Model B13 Drawers	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Must be defined as a 3390. Attaches to 3990 Model 3 or Model 6 Storage Control.</p> <p>Only 3390 Model 3 is supported for installation of z/VM 5.1.0.</p>
RAMAC Virtual Array Subsystem: 9393 Model 002, T42, or T82	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Emulates a 3990 Model 3 Storage Control with 3390 Model 1, 2, and 3 DASD or 3380 Model J and K DASD.</p> <p>Supported for installation of z/VM 4.3.0 or later only when emulating a 3390.</p> <p>Mixed 3390 models are not supported for installation of z/VM 4.3.0 or later.</p> <p>Only 3390 Model 3 is supported for installation of z/VM 5.1.0.</p>
RAMAC Array Subsystem: 9394 Model 001, 002, or 003 Cluster Array Controller with 9395 Model B13 or B23 Drawers	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Emulates a 3990 Model 2 Storage Control with 3390 Model 3 DASD or 3380 Model K DASD.</p> <p>Supported for installation of z/VM 4.3.0 or later only when emulating a 3390.</p> <p>Mixed 3390 models are not supported for installation of z/VM 4.3.0 or later.</p> <p>Only 3390 Model 3 is supported for installation of z/VM 5.1.0.</p>

## Device Support

Table 6. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
Internal Disk (for Multiprise 2000)	z/VM 3.1.0	<p>This device is a feature of the S/390 Multiprise 2000 server.</p> <p>Emulates a 3990 Model 2 Storage Control with 3390 Model 1, 2, 3, and 9 DASD or 3380 Model E, J, and K DASD.</p> <p>3390 Model 9 is not supported for installation of z/VM 3.1.0.</p>
Internal Disk (for Multiprise 3000)	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	<p>This device is a feature of the S/390 Multiprise 3000 Enterprise Server.</p> <p>Emulates a 3990 Model 2 Storage Control with 3390 Model 1, 2, 3, and 9 DASD or 3380 Model E, J, and K DASD.</p> <p>3390 Model 9 is not supported for installation of z/VM 3.1.0, z/VM 4.3.0, or z/VM 4.4.0.</p> <p>Supported for installation of z/VM 4.3.0 or later only when emulating a 3390 Model 1, 2, or 3.</p> <p>Mixed 3390 models are not supported for installation of z/VM 4.3.0 or later.</p> <p>The performance-oriented track level commands are supported for guest use only.</p> <p>VM240 requires APAR VM62180.</p> <p>IOCP requires APAR VM62312.</p> <p>For ICKDSF support information, see the ICKDSF Program Directory.</p>

Table 6. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
TotalStorage Enterprise Storage Server (2105) [ESCON or FICON attached]	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Supported only in emulation mode. Must be defined as a 3990 Model 3 or 6 Storage Control with either of the following:</p> <ul style="list-style-type: none"> <li>• 3390 Model 2, 3, and 9 DASD</li> <li>• 3390 Model 2 and 3 DASD in 3380 track compatibility mode</li> </ul> <p>3390 Model 9 is not supported for installation of z/VM 3.1.0, 4.3.0, or 4.4.0.</p> <p>Mixed 3390 models are not supported for installation of z/VM 4.3.0 or later.</p> <p>Only 3390 Model 3 or 9 are supported for installation of z/VM 5.1.0.</p> <p>The performance-oriented track level commands are supported for guest use only.</p> <p>To use the Parallel Access Volumes feature, the device must be dedicated to a guest.</p> <p>To support more than 10017 cylinders on a 3390 Model 9:</p> <ul style="list-style-type: none"> <li>• CP on z/VM 3.1.0 requires APAR VM62767 if CSE XLINK minidisks are used.</li> <li>• CMS on z/VM 3.1.0 requires APAR VM62936.</li> <li>• GCS on z/VM 3.1.0 requires APAR VM62937.</li> <li>• DFSMS/VM Function Level 221 requires APAR VM63004.</li> <li>• DirMaint 1.5.0 or DirMaint Function Level 410 requires APAR VM62907.</li> </ul> <p>For guest use of FlashCopy, the device must be dedicated to the guest or defined as a fullpack minidisk.</p> <p>PPRC-XD is supported for guest use only. Native use of PPRC-XD requires ICKDSF V1R17.</p> <p>On z/VM 3.1.0 or z/VM 4.3.0, APAR VM63256 is required to support FlashCopy V2 and PPRC V2. PPRC V2 is supported for guest use only.</p> <p>For ICKDSF support information, see the ICKDSF Program Directory.</p>

## Device Support

Table 6. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
TotalStorage Enterprise Storage Server (2105) [FCP attached]	z/VM 5.1.0	<p>For native z/VM use, the ESS volumes appear as 9336-20 DASD.</p> <p>For guest use, the ESS volumes can appear either as 9336-20 DASD or as SCSI LUNs directly accessed through FCP subchannels.</p>
TotalStorage DS8000 (2107) [ESCON or FICON attached]	z/VM 4.4.0, z/VM 5.1.0	<p>APAR VM63534 is required.</p> <p>Supported only in emulation mode. Must be defined as a 3990 Model 3 or 6 Storage Control with either of the following:</p> <ul style="list-style-type: none"> <li>• 3390 Model 2, 3, and 9 DASD</li> <li>• 3390 Model 2 and 3 DASD in 3380 track compatibility mode</li> </ul> <p>Mixed 3390 models are not supported for installation of z/VM.</p> <p>3390 Model 9 is not supported for installation of z/VM 4.4.0.</p> <p>Only 3390 Model 3 or 9 are supported for installation of z/VM 5.1.0.</p> <p>The performance-oriented track level commands are supported for guest use only.</p> <p>To use the Parallel Access Volumes feature, the device must be dedicated to a guest.</p> <p>DFSMS/VM FL221 support for 3390 Model 9 disks larger than 10017 cylinders requires APAR VM63004.</p> <p>DirMaint FL410 support for 3390 Model 9 disks with 10018-32760 cylinders requires APAR VM62907.</p> <p>DirMaint FL410 or FL510 support for 3390 Model 9 disks larger than 32760 cylinders requires APAR VM63656.</p> <p>For guest use of FlashCopy, the device must be dedicated to the guest or defined as a fullpack minidisk.</p> <p>PPRC is supported for guest use only. Native use of PPRC requires ICKDSF V1R17.</p> <p>For ICKDSF support information, see the ICKDSF Program Directory.</p>

Table 6. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
TotalStorage DS8000 (2107) [FCP attached]	z/VM 5.1.0	<p>APAR VM63534 is required.</p> <p>For native z/VM use, the DS8000 volumes appear as 9336-20 DASD.</p> <p>For guest use, the DS8000 volumes can appear either as 9336-20 DASD or as SCSI LUNs directly accessed through FCP subchannels.</p> <p>DirMaint FL510 support for SCSI LUNs larger than 381 GB requires APAR VM63656.</p>

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## Device Support

Table 6. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
TotalStorage DS6000 (1750) [FICON attached]	z/VM 4.4.0, z/VM 5.1.0	<p>APAR VM63535 is required.</p> <p>Supported only in emulation mode. Must be defined as a 3390 Model 3 or 6 Storage Control with either of the following:</p> <ul style="list-style-type: none"> <li>• 3390 Model 2, 3, and 9 DASD</li> <li>• 3390 Model 2 and 3 DASD in 3380 track compatibility mode</li> </ul> <p>Mixed 3390 models are not supported for installation of z/VM.</p> <p>3390 Model 9 is not supported for installation of z/VM 4.4.0.</p> <p>Only 3390 Model 3 or 9 are supported for installation of z/VM 5.1.0.</p> <p>The performance-oriented track level commands are supported for guest use only.</p> <p>To use the Parallel Access Volumes feature, the device must be dedicated to a guest.</p> <p>DFSMS/VM FL221 support for 3390 Model 9 disks larger than 10017 cylinders requires APAR VM63004.</p> <p>DirMaint FL410 support for 3390 Model 9 disks with 10018-32760 cylinders requires APAR VM62907.</p> <p>DirMaint FL410 or FL510 support for 3390 Model 9 disks larger than 32760 cylinders requires APAR VM63656.</p> <p>For guest use of FlashCopy, the device must be dedicated to the guest or defined as a fullpack minidisk.</p> <p>PPRC is supported for guest use only. Native use of PPRC requires ICKDSF V1R17.</p> <p>For ICKDSF support information, see the ICKDSF Program Directory.</p>

Table 6. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
TotalStorage DS6000 (1750) [FCP attached]	z/VM 5.1.0	<p>APAR VM63535 is required.</p> <p>For native z/VM use, the DS6000 volumes appear as 9336-20 DASD.</p> <p>For guest use, the DS6000 volumes can appear either as 9336-20 DASD or as SCSI LUNs directly accessed through FCP subchannels.</p> <p>DirMaint FL510 support for SCSI LUNs larger than 381 GB requires APAR VM63656.</p>

## DASD Control Units and Storage Controls

Table 7. Device Support List—DASD Control Units and Storage Controls

Device	z/VM Releases Providing Support	Support Notes
3830 Model 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	
3880 Model 1, 3, 4	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	
3880 Model E21, G21, H21, J21, D23, E23, G23, H23, J23	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	
3990 Model 1, 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3990 Model 3	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Concurrent Copy function supported for guest use only.
3990 Model 6	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>All functions of former 3990 models supported plus increased cache, System Clock Support, and the Control Unit Initiated Reconfiguration feature (CUIR).</p> <p>Concurrent Copy and Extended Remote Copy functions are supported for guest use only.</p>
9221 DASD/Tape Subsystem Control	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	
9335 Model A01	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	
9340 Direct Access Storage Subsystem: 9341 Model A02 9343 Model C02, C04	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	
9340 Direct Access Storage Subsystem: 9343 Model D04	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	ESCON-attached only.
9340 Direct Access Storage Subsystem: 9343 Model CC2, CC4	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Models CC2 and CC4 are cache models (basic caching only). The cache function is not visible to or controllable by software. No additional z/VM support is required.

## Device Support

Table 7. Device Support List—DASD Control Units and Storage Controls (continued)

Device	z/VM Releases Providing Support	Support Notes
9340 Direct Access Storage Subsystem: 9343 Model DC4	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	ESCON-attached only. Model DC4 is a cache model (basic caching only). The cache function is not visible to or controllable by software. No additional z/VM support is required.

## Tape Units and Tape Libraries

Table 8. Device Support List—Tape Units and Tape Libraries

Device	z/VM Releases Providing Support	Support Notes
2440	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Must be defined as a 3420 Model 4. Not supported for z/VM installation.
3420 Model 3, 4, 5, 6, 7, 8	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
3422 Tape Unit and Control	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
3424 Tape Subsystem	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	For Brazil only. Not supported for z/VM installation.
3430	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.
3480 Tape Subsystem	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Non-XF not supported for installation of z/VM 4.3.0 or later.
3490 Tape Subsystem	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3490E (Enhanced Capability Model) Tape Subsystem	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
TotalStorage Enterprise Automated Tape Library (3494)	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Native support is provided in conjunction with DFSMS/VM. Not supported for z/VM installation.
TotalStorage Virtual Tape Server (3494 VTS)	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Native support is provided in conjunction with DFSMS/VM. Not supported for z/VM installation. z/VM 3.1.0 and later support Peer-to-Peer VTS and VTS Import/Export feature for guests.
3495 Tape Library Dataserver	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Native support is provided in conjunction with DFSMS/VM. Not supported for z/VM installation.
TotalStorage Enterprise Tape System (3590)	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Not supported for z/VM 3.1.0 installation. To support the 3590 Model H: <ul style="list-style-type: none"> <li>• CP on z/VM 3.1.0 or z/VM 4.3.0 requires APAR VM63074.</li> <li>• CMS on z/VM 3.1.0 requires APAR VM63073.</li> <li>• DFSMS/VM FL221 requires APAR VM63097.</li> </ul>

Table 8. Device Support List—Tape Units and Tape Libraries (continued)

Device	z/VM Releases Providing Support	Support Notes
TotalStorage Enterprise Tape Drive (3592)	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Not supported for z/VM installation.  For basic device support: <ul style="list-style-type: none"> <li>• CP on z/VM 3.1.0, z/VM 4.3.0, or z/VM 4.4.0 requires APAR VM63325.</li> <li>• DFSMS/VM FL221 requires APAR VM63353.</li> </ul> To support Write Once Read Many (WORM) media: <ul style="list-style-type: none"> <li>• CP on z/VM 3.1.0, z/VM 4.3.0, or z/VM 4.4.0 requires APAR VM63461.</li> <li>• DFSMS/VM FL221 requires APAR VM63460.</li> </ul>
9348 Model 11, 12	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	Not supported for z/VM installation.

## Tape Control Units

Table 9. Device Support List—Tape Control Units

Device	z/VM Releases Providing Support	Support Notes
TotalStorage Enterprise Tape Controller 3590 Model A60	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	To support native FICON attachment of the A60, z/VM 3.1.0 requires APAR VM62710.
3803 Model 1, 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	

## Printers

Table 10. Device Support List—Printers

Device	z/VM Releases Providing Support	Support Notes
3203 Model 5	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3262	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3268 Model 2, 2C	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be defined as a 3287.
3287 Model 1, 1C, 2, 2C, 4	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3289 Model 1, 3, 4, 8	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3800 Model 1	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3800 Model 3, 6, 8	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Full support in Model 1 compatibility mode or using Advanced Function Printing™ (AFP™) licensed programs.

## Device Support

Table 10. Device Support List—Printers (continued)

Device	z/VM Releases Providing Support	Support Notes
3812	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Full support through RSCS 3.1.1 or later, using Advanced Function Printing licensed programs; downloading of fonts is not supported. Loading of fonts requires Print Services Facility™/VM (PSF/VM) licensed program (program number 5684-141).
3816 Model 01D, 01S	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Full support through RSCS 3.1.1 or later, using AFP licensed programs; downloading of fonts is not supported. Loading of fonts requires PSF/VM licensed program.
3820	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Full support through VM/VTAM, using AFP licensed programs.
3825	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Full support using AFP licensed programs.
3827	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Full support using AFP licensed programs.
3835	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Full support using AFP licensed programs.
3900	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be defined as a 3800.
4245 Model 1	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Supported as a 4245 or in 3262 compatibility mode.
4245 Model 12, 20	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
4248 Model 1, 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Supported as a 4248 or in 3211 compatibility mode.
6262 Model 14, 22	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be defined as a 4248 Model 1.

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## Card Readers and Card Punches

Table 11. Device Support List—Card Readers and Card Punches

Device	z/VM Releases Providing Support	Support Notes
3505 Model B1, B2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3525 Model P1, P2, P3	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	

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## Terminals/Displays/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 4.4.0 also supports the integrated 3270 console function of the Hardware Management Console.

## Display Printers

Most display printers are supported using Advanced Function Printing (AFP) licensed programs through RSCS.

## Display Control Units

Table 12. Device Support List—Display Control Units

Device	z/VM Releases Providing Support	Support Notes
3174	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3272 Model 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3274	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3276 Display/Control Unit	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device.

## Communications Controllers

Table 13. Device Support List—Communications Controllers

Device	z/VM Releases Providing Support	Support Notes
3705	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device.
3720	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device. Must be defined as a 3705, unless you are using dynamic system configuration.
3725	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device. Must be defined as a 3705, unless you are using dynamic system configuration.
3745	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device. Must be defined as a 3705, unless you are using dynamic system configuration.
9221 Integrated Communications Attachment	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0	

## Switches

Table 14. Device Support List—Switches

Device	z/VM Releases Providing Support	Support Notes
2032 FICON Director Model 1	z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
9032 ESCON Director Model 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
9032 ESCON Director Model 3	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	

## Device Support

Table 14. Device Support List—Switches (continued)

Device	z/VM Releases Providing Support	Support Notes
9032 ESCON Director Model 5	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
9033 ESCON Director Model 1	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
9033 ESCON Director Model 4	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
<p><b>Note:</b> Control units and I/O devices with parallel channels can be attached to ESCON channels through the ESCON Converter Model 1. (See your IBM representative for a list of parallel devices that the ESCON Converter Model 1 supports.) Conversely, the ESCON Converter Model 2 allows ESCON devices to be attached to servers that have parallel channels.</p> <p>For more information about ESCON architecture, see <i>Introducing Enterprise Systems Connection</i>, GA23-0383.</p>		

## Miscellaneous Devices and Server Features

Table 15. Device Support List—Miscellaneous Devices

Device/Feature	z/VM Releases Providing Support	Support Notes
Channel-to-Channel Adapter (CTCA)	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device.
Crypto Express2	z/VM 5.1.0	Must be dedicated to a Linux on zSeries or z/OS guest as a supported device.
ESCON CTCA	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Extended mode operation only.
FICON CTCA	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a guest as a supported device. z/VM 3.1.0 requires APAR VM62906.
HiperSockets	z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device.
OSA-2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device.  OSA/SF is required to customize the OSA modes. OSA/SF can be running either in an LPAR in the same system complex or as a z/VM guest. OSA/SF for z/VM can be run as a CMS application.  OSA-2 is recognized as TYPE=OSA.

Table 15. Device Support List—Miscellaneous Devices (continued)

Device/Feature	z/VM Releases Providing Support	Support Notes
OSA-Express	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Must be dedicated to a virtual machine as a supported device.</p> <p>OSA/SF is required to customize the OSA-Express modes. OSA/SF can be running either in an LPAR in the same system complex or as a z/VM guest. OSA/SF for z/VM can be run as a CMS application.</p> <p>OSA-Express is recognized as TYPE=OSE for the Fast Ethernet and 155 ATM modes.</p> <p>OSA-Express is recognized as TYPE=OSD for the Gigabit Ethernet mode.</p> <p>OSA-Express is recognized as TYPE=OSC for the 1000BASE-T Ethernet feature with the Integrated Console Controller (ICC) function.</p> <p>Support for TCP/IP stack utilization improvements requires APARs PQ91421 and VM63524.</p>
OSA-Express2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Must be dedicated to a virtual machine as a supported device.</p> <p>OSA/SF is required to customize the OSA-Express2 modes. OSA/SF can be running either in an LPAR in the same system complex or as a z/VM guest. OSA/SF for z/VM can be run as a CMS application.</p> <p>OSA-Express2 is recognized as TYPE=OSD for the Gigabit Ethernet and 10 Gigabit Ethernet modes.</p> <p>Support for TCP/IP stack utilization improvements on z/VM V5R1 (not supported on prior releases) requires APARs PQ91421 and VM63524.</p>
PCI Cryptographic Accelerator	z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Must be dedicated to a Linux on zSeries guest as a supported device.</p> <p>DirMaint Function Level 410 requires APAR VM62933.</p>
PCI Cryptographic Coprocessor	z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	<p>Must be dedicated to a Linux on zSeries guest as a supported device.</p> <p>DirMaint Function Level 410 requires APAR VM62933.</p>
PCIX Cryptographic Coprocessor (Crypto Express)	z/VM 5.1.0	<p>Must be dedicated to a Linux on zSeries or z/OS guest as a supported device.</p>

## Device Support

Table 15. Device Support List—Miscellaneous Devices (continued)

Device/Feature	z/VM Releases Providing Support	Support Notes
3088	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device.
3088 Model 61 PSCA Card (common link access to workstations)	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3172 Model 1, 2, 3	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device.
3174 Model 12L, 22L	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
3737 Remote Channel-to-Channel Unit Model 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device. Must be defined as a CTCA.
3890™	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a guest as a supported device.
4753 Network Security Processor	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a guest as a supported device.
7171 Device Attachment Control Unit	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	The 7171 ASCII Device Attachment Control Unit (DACU) allows the attachment of ASCII terminals locally or (through Start-Stop communication line) remotely. The ASCII terminals appear to the host as 3277s, 3278s, and 3279s, with the DACU itself appearing as a 3274 control unit.
8232 LAN Channel Station	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	Must be dedicated to a virtual machine as a supported device. Supported by TCP/IP for z/VM.
9034 ESCON Converter Model 1	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	
9035 ESCON Converter Model 2	z/VM 3.1.0, z/VM 4.3.0, z/VM 4.4.0, z/VM 5.1.0	

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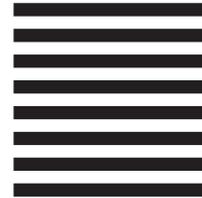
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