

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



# General Information

*Version 4 Release 4.0*



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# General Information

*Version 4 Release 4.0*

**Note:**

Before using this information and the product it supports, read the information in “Notices” on page 103.

**Sixth Edition (May 2003)**

This edition applies to version 4, release 4, modification 0 of IBM® z/VM® (product number 5739-A03) and to all subsequent releases and modifications until otherwise indicated in new editions.

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## Preface

This book provides general information about the IBM z/VM Version 4 Release 4.0 (z/VM 4.4.0) licensed program.

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## Who Should Read This Book

This book is intended for current users of IBM VM products, as well as new users. It provides information to help users evaluate z/VM 4.4.0 and determine the resources necessary to run it. This book is also intended for anyone interested in a general overview or introduction to z/VM.

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## What This Book Contains

This book contains:

- An introduction to z/VM
- A summary of the new functions, enhancements, and other changes in z/VM 4.4.0
- Technical information, such as hardware and program requirements, packaging information, and product restrictions
- Descriptions of the z/VM base components and facilities and the z/VM optional features
- A guide to the z/VM product documentation
- Information about the IBM servers, guest operating systems, and devices supported by z/VM

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## Where to Find More Information

You can obtain more information about z/VM from the Web sites and books listed in the z/VM library guide, which begins on page 61. The library guide includes an abstract for each book in the z/VM library.

**Note:** Because this book is published for the announcement of z/VM 4.4.0, some sources of additional information identified in this book may not be available until the general availability of z/VM 4.4.0.

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## Chapter 1. Introducing z/VM

IBM z/VM, Version 4 Release 4.0, is a high-performance, interactive, multiple-access operating system for IBM *@server* zSeries® and IBM S/390® servers. It provides a unique mix of services in support of interactive users and client/server environments, and its implementation of IBM virtualization technology provides the capability to run full-function operating systems such as Linux and z/OS™ as “guest” systems.

**Note:** z/VM is the successor to IBM’s VM/ESA® operating system. Some products and functions supported on z/VM and some publications might continue to use VM/ESA in their names.

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

- Control Program (CP)
- Conversational Monitor System (CMS)
- TCP/IP for z/VM
- APPC/VM VTAM® Support (AVS)
- Data Facility Storage Management Subsystem for VM (DFSMS/VM®)
- Dump Viewing Facility
- Group Control System (GCS)
- Hardware Configuration Definition and Hardware Configuration Manager for z/VM (HCD and HCM for z/VM)
- Language Environment®
- Open Systems Adapter Support Facility (OSA/SF)
- REXX/VM
- Transparent Services Access Facility (TSAF)
- Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E)

For more information, see Chapter 4, “z/VM Base Product”, on page 37.

z/VM also offers the following optional features:

- Directory Maintenance Facility (DirMaint™)
- Performance Reporting Facility (PRF)
- Performance Toolkit for VM™
- RealTime Monitor (RTM)
- Resource Access Control Facility for z/VM (RACF® for z/VM)

For more information, see Chapter 5, “z/VM Optional Features”, on page 57.

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## 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

The network computing paradigm is not new to VM. 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 data to customers on the Internet and the World Wide Web. Through the use of shareware or IBM

## Introducing z/VM

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 provides common protocols and applications that enable access to data from heterogeneous system platforms.
- **IBM® Java™ Port for VM/ESA.** The object-oriented Java programming language permits object code portability across any platform that supports Java. This is an ideal technology for building intranet/Internet applications using standard gateway interfaces.
- **NetRexx™.** NetRexx is a general-purpose programming language that is a blend of the Rexx and Java languages. You can use NetRexx as an alternative to Java, which makes writing and using Java classes quicker and easier than writing in Java.
- **MQSeries® Client for VM/ESA.** IBM WebSphere® MQ (formerly MQSeries) enables applications on different systems and architectures to work together. z/VM support for WebSphere MQ enables client or server applications in the network to connect to applications on z/VM that have implemented the WebSphere MQ communication protocol. (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 interfaces 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)
- File transfer protocol (FTP)
- IEEE Virtual Local Area Network (VLAN)
- Network file system (NFS)
- Simple mail transfer protocol (SMTP)
- Systems Network Architecture (SNA)
- TCP/IP
- 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) and through IBM-defined interfaces supported in NetView®.

## 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).** DB2 Server for VM 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 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. (To provide full support for z/Architecture guests, z/VM must be running on a zSeries server.) 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 87.

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 the primary operating system, or of z/VM itself, can be generated and tested at the same time the existing release is performing production work. This enables the new release to be installed more quickly. The ability to operate multiple operating systems concurrently under z/VM may enable an installation to continue running programs 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.

## Introducing z/VM

- **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 the primary operating system and z/VM 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 disk devices can be determined in this way using the existing smaller I/O configuration. Experience with generating and operating a z/OS or OS/390® multiple-system configuration 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 product in a client/server environment:

- **Tivoli® Storage Manager for VM.** Tivoli Storage Manager is a client/server tool that enables backup, archiving, and restoration of workstation files, utilizing the host z/VM system and 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, Apple Macintosh, and OS/2®.

---

## z/VM Supports Application Development and Deployment

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

- APL2®
- Assembler
- C
- C++
- COBOL
- FORTRAN
- Java
- Language Environment
- MQSeries Client (WebSphere MQ)
- NetRexx

- PASCAL
- PL/I
- REXX
- Systems Application Architecture® (SAA®) common programming interface (CPI)
- VisualAge® 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.

Special 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

---

### **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 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 32.

- 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 or OS/390.
  - z/VM provides duplexed data with transparent ongoing synchronization between the primary and backup copy, and automatic transparent cut-over to the backup copy in case of an error in the primary copy.
  - On-line 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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## Chapter 2. New Functions, Enhancements, and Other Changes

This chapter provides an overview of the new functions and enhancements provided in z/VM 4.4.0.

- “Virtualization Technology and Linux Enablement”
- “Network Virtualization” on page 10
- “Technology Exploitation” on page 11
- “Systems Management” on page 14
- “Network Performance and Security” on page 15
- “Application Enablement” on page 16
- “Product Information” on page 17
- “Other Changes” on page 18

**Note:** For descriptions of functions and enhancements added in previous releases, see the *z/VM: Migration Guide*.

---

### Virtualization Technology and Linux Enablement

This section describes extensions to z/VM virtualization technology in support of Linux and other guests while providing some enhancements that enable z/VM to be self-optimized and self-managed.

### Enhanced Queued Direct I/O (QDIO) Performance

z/VM 4.4.0 and the new IBM @server zSeries 990 (z990) are designed to provide important performance improvements to the QDIO architecture originally introduced with the Open Systems Adapter-Express (OSA-Express). Use of the QDIO architecture was later extended to HiperSockets and the Fibre Channel Protocol (FCP) channels. The architecture itself was extended in HiperSockets to include a new type of high-performance I/O interruption known as an adapter interruption.

The use of adapter interruptions has been extended to the OSA-Express and FCP channels on the z990 server. This allows OSA-Express adapters (for networking) and FCP channels (for Fibre Channel fabrics) to join HiperSockets in benefitting from the higher performance characteristics of these interruptions.

In addition to the use of adapter interruptions by the OSA-Express and FCP channels, the z990 server is designed to include a performance assist for the virtualization of adapter interruptions being given to guest operating systems. This hardware performance assist is available to V=V guests (pageable guests) that support QDIO on z/VM 4.4.0.

This new IBM virtualization technology is designed to benefit all guest operating systems in environments where they can process adapter interruptions. This includes all users of HiperSockets, and guest operating systems that add adapter-interruption support for OSA-Express and FCP channels. With the enhancement of the TCP/IP stack in z/VM 4.4.0 to use adapter interruptions for OSA-Express, TCP/IP for z/VM can benefit from this performance assist for both HiperSockets and OSA-Express.

## Linux Guest Capacity Improvements

Improvements to the z/VM Control Program (CP) scheduler increase the number of Linux and other guest virtual machines that can be managed concurrently. While this increase in capacity can be experienced on all zSeries hardware configurations, it may be more dramatic on larger n-way servers. The scheduler lock is used to serialize scheduler activities, timer request block management, and processor local dispatch vector (PLDV) management. Because contention on the lock is lowered by creating a new lock for timer request block management, CP overhead can be decreased.

## Systems Management APIs

The systems management application programming interfaces (APIs) provide a basic set of functions that can 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 for managing any type of virtual image running in a z/VM virtual machine. The APIs are designed so that applications can be written by customers or solution providers to help administrators, especially those who lack in-depth VM knowledge, manage large numbers of virtual images running in a single z/VM system.

Functions supported by the systems management APIs allow you to:

- Create and delete virtual images
- Add and remove resources in an image's static (directory) or dynamic (active) configuration
- Activate and deactivate virtual images (individual or lists)
- Manage connectivity between virtual images, including exploitation of the new virtual switch support
- Query the status of "long-running" asynchronous operations initiated through the APIs
- Create, delete, replace, and query shared storage segments

The systems management APIs require a directory manager. The IBM Directory Maintenance Facility (DirMaint) optional feature of z/VM has been enhanced with support for these APIs through a service upgrade. See "DirMaint Program Requirements" on page 25.

Client applications invoke the systems management APIs through a set of IBM-supplied Remote Procedure Calls (RPCs) to a z/VM server machine (either remotely or from within the z/VM system). The server then calls a set of CMS 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. For more information, see *z/VM: Systems Management Application Programming*.

## Virtual Machine Resource Manager (VMRM) Enhancements

VMRM has been enhanced to provide the infrastructure necessary to support more extensive workload and systems resource management features that may be delivered in future releases of z/VM. To accomplish this objective, the following have been added:

- Monitor data showing actual workload achievements
- An interface to dynamically change users in workloads, workload characteristics, and goals in the VMRM configuration file without manually stopping the server

- More flexibility when managing multiple users by supporting wild-card characters on user IDs in the configuration file
- Improvements to the reliability and performance of the VMRM service virtual machine's handling of monitor data
- Serviceability enhancements, including improved messages, logfile entries, and new server options

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

## **Secure Sockets Layer (SSL) Upgrade for Linux**

The upgraded SSL server shipped with TCP/IP on z/VM 4.4.0 provides appropriate Red Hat Package Manager (RPM) packages for the SuSE Linux 2.4.7 SLES 7 and 2.4.19 SLES 8 distributions. This upgrade helps avoid potential support issues with the backlevel 2.2.16 Linux kernel and allows the SSL server to exploit the many performance improvements in the Linux 2.4 kernel.

## **Guest IPL from Small Computer System Interface (SCSI) Disks**

z/VM 4.4.0 allows initial program loading (IPLing) from FCP-attached SCSI disks for Linux and other guest operating systems that contain support for IPLing from FCP-attached SCSI disks, when z/VM is running on a z990, z900, z800, or equivalent server equipped with the function for IPLing from FCP-attached disks. IBM intends to make this hardware function available in the future. When this hardware function becomes available, Linux guests can be started and run completely from FCP-attached SCSI disks in your hardware configuration. z/VM continues to require ESCON<sup>®</sup>-attached or FICON<sup>™</sup>-attached disk or tape for its own IPL and other functions.

## **Virtual FICON Channel-to-Channel Adapters (CTCAs)**

z/VM 4.4.0 provides virtual FICON CTCAs for guest operating systems. Guests use virtual CTCAs to communicate among themselves within a single z/VM system image, without the need for hardware CTCAs. Virtual CTCAs provide high-performance communication because z/VM simply moves data in system memory between the communicating virtual machines.

Earlier releases of z/VM provided support for hardware FICON CTCAs, and this support carries forward into z/VM 4.4.0. Virtual FICON CTCA devices enhance previous virtual-CTCA capabilities by adding the FICON protocol as an option for guest operating systems. Virtual CTCAs now support the 3088, ESCON, and FICON protocols. With the new FICON-protocol support, customers who use real FICON CTCAs in production can run their test configurations as guests on z/VM in exactly the same way as will be done in production.

## **Integrated 3270 Console**

z/VM 4.4.0 adds support for real and virtual integrated 3270 console devices. Real support enables this device, which is provided through a Hardware Management Console, to be used as a z/VM system operator console. This removes the requirement to have an external 3270 device to install and service z/VM 4.4.0. The z/VM Stand Alone Program Loader (SAPL) and stand-alone DASD Dump-Restore (DDR) program support using the integrated 3270 console as a system operator console. Virtual support enables testing of guest operating systems and utilities that support the integrated 3270 console device. There may be additional hardware

## New in z/VM 4.4.0

requirements to use this support; see Appendix A, “IBM Servers Supported by z/VM”, on page 83. For more information about using the integrated 3270 console, see *z/VM: System Operation*.

## Guest Coupling Enhancement

z/VM's virtual Coupling Facility (CF) support has been enhanced in z/VM 4.4.0 to allow z/VM systems to run as second-level (or higher) guests while simulating complete OS/390 and z/OS coupled sysplexes. This enhanced support loads the Coupling Facility Control Code (CFCC) from the Service Element of a zSeries or S/390 server into CF service virtual machines in a z/VM system running as a second-level (or higher) guest of z/VM 4.4.0. This allows you to test an OS/390 or z/OS Parallel Sysplex<sup>®</sup> environment at any guest level.

**Note:** Each additional level of guest virtualization incurs a performance penalty that may make running a Parallel Sysplex impractical at higher guest levels.

---

## Network Virtualization

This section describes enhancements to the virtualization of networks in z/VM.

### IEEE Virtual Local Area Network (VLAN) Support

IEEE Virtual LAN (VLAN) standard 802.1q describes a mechanism that is designed to enable groups of hosts to be logically connected into a single Local Area Network (LAN) even though they are connected to different switches in different physical locations. Network hosts can be organized into LAN segments which fit an organization's network traffic patterns, rather than being dependent on physical location. In addition, by connecting a router to multiple VLANs, savings can be realized by providing router connections to new LAN segments without having to add additional network interfaces to the routers.

To support IEEE VLANs, z/VM 4.4.0 provides:

- Enhancements to TCP/IP for z/VM to enable membership in a VLAN for IBM zSeries OSA-Express (QDIO) and HiperSockets adapters that support IEEE 802.1q
- Enhancements to z/VM's virtual QDIO and HiperSockets network interface simulation to support VLAN frame tagging as described by IEEE 802.1q
- Management and control of the VLAN identifiers (VIDs) that can be used by guest virtual machines

### Network Consolidation Using the Virtual Switch

z/VM 4.4.0 further enhances virtualization technology by introducing a virtual IP switch that is capable of bridging a z/VM Guest LAN to an associated real LAN connected by an OSA-Express adapter. The z/VM virtual switch is designed to help eliminate the need for virtual machines acting as routers to provide IPv4 connectivity to a physical LAN through an OSA-Express adapter. Further, it eliminates the need to define a separate routable subnet for the exclusive use of the members of a Guest LAN. Using the virtual switch, the convenience of a Guest LAN is maintained while allowing the guests to be assigned IP addresses in the real LAN subnet.

Virtual routers consume valuable processor cycles to process incoming and outgoing packets, requiring additional copying of the data being transported. The virtual switch helps alleviate this problem by moving the data directly between the real network adapter and the target or originating guest data buffers.

Centralized network configuration and control of the virtual switch within CP allows the z/VM Guest LAN administrator to more easily grant and revoke access to the real network and to manage the configuration of Guest LAN VLAN segments. While the z/VM system can be a member of multiple VLANs, the z/VM Guest LAN administrator can control which guests belong to which real VLAN, without requiring additional network adapters or switch port configuration. If a guest does not support IEEE 802.1q, z/VM will transparently join the virtual network interface into the desired VLAN.

The z/VM virtual switch employs transparent bridging to enable the switch to dynamically determine and maintain node connectivity so that the LAN administrator has less network maintenance to perform. For more information, see *z/VM: Virtual Machine Operation*.

## **Guest LAN Support of Internet Protocol version 6 (IPv6)**

The z/VM Guest LAN support for OSA-Express simulation in QDIO mode has been updated for IPv6. Virtual machines in the Guest LAN environment can define and use simulated OSA-Express devices that support both the IPv4 and IPv6 protocols.

## **Extended HiperSockets Support**

In addition to the VLAN support in TCP/IP for z/VM and Guest LAN simulation, TCP/IP broadcast support is provided for the HiperSockets environment when utilizing IPv4 with z/VM 4.4.0. Applications that use the broadcast function can now propagate broadcast frames to all TCP/IP applications when using either HiperSockets or an OSA-Express (QDIO) adapter.

---

## **Technology Exploitation**

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

**Note:** Exploitation of some new hardware functions may depend on hardware level or availability. For detailed information on hardware capabilities and requirements, refer to the appropriate hardware announcements.

## **Exploitation of the New IBM @server zSeries 990 (z990)**

The z990 is the latest zSeries enterprise server of the IBM @server brand, providing new and unique functions and features to meet today's e-business on demand™ challenges. z/VM 4.4.0 plans to support the following functions of the z990 server at the general availability of z/VM 4.4.0, planned for August 15, 2003.

### **Logical Channel Subsystems**

A new logical channel subsystem (LCSS) structure is introduced with the z990 to “break the barrier” of 256 channels per server machine. This new facility is designed to allow the definition of more than one channel subsystem (CSS), 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.

Support for dynamic I/O configuration on z/VM 4.4.0 has been extended to allow channel paths, control units, and devices to be dynamically added, changed, and deleted in multiple logical channel subsystems when z/VM 4.4.0 is running on a z990 server with the applicable hardware support. IBM plans to provide this hardware support (such as dynamic-I/O configuration in a multiple logical channel subsystem) in October 2003. When z/VM 4.4.0 is running on a z990 server and is

## New in z/VM 4.4.0

the controlling logical partition for dynamic-I/O configuration, z/VM is designed to handle all of the new elements of each CSS facility for changing your hardware I/O configuration. To dynamically change the I/O configuration, one of two methods can be employed:

- CP's suite of interactive dynamic-I/O-configuration commands
- HCD and HCM configuration-management tools

### Spanned Channels

IBM plans to support transparent sharing of HiperSockets channels across multiple logical channel subsystems on the z990 server in October 2003, extending the sharing capabilities now provided by the Multiple Image Facility (MIF). MIF allows sharing of channel resources across logical partitions. In October 2003, HiperSockets channels (IQD CHPID-type) 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.

With z/VM 4.4.0, spanned HiperSockets channels help enable inter-process communication (IPC) among Linux guests running on VM images in different logical partitions, when the VM images are using different logical channel subsystems. Other IPC configurations are also supported, such as a HiperSockets link between a stand-alone Linux logical partition using one logical channel subsystem and a Linux guest of a VM image in another logical partition using another logical channel subsystem.

### Extended Channel Measurement Data Support (ECMDS)

IBM plans to provide extended I/O-measurement facilities in the z990 server. z/VM 4.4.0 supports this new z990 function, which provides an extended I/O-measurement block for each subchannel and an extended measurement word at the completion of each I/O operation. Each extended I/O-measurement block has its own 64-bit address, allowing the measurement blocks to be stored in noncontiguous real memory. The extended measurement word provides channel measurement data for each I/O operation when it completes, streamlining measurement processing in the operating system.

### Support for 30 Logical Partitions (LPARs)

Prior to the z990, there was an LPAR limit of 15. IBM plans to increase this limit for the z990 server in October 2003. z/VM 4.4.0 can handle I/O-configuration definition and dynamic-I/O configuration for up to 30 LPARs. In addition, the CP Monitor has been updated to allow performance data to be collected and recorded for z/VM systems running on servers with more than 15 LPARs.

## Cascaded FICON Directors

z/VM 4.4.0 supports the zSeries capability to cascade two FICON directors within a fibre-channel fabric. z/VM and its guests can take advantage of this enhanced and simplified connectivity, which is particularly useful in disaster-recovery and business-continuity procedures.

The z/VM support for cascaded FICON directors is embodied in support for two-byte fibre-channel link addresses when defining and configuring control units within the fabric. Previously, only single-byte link addresses were needed in a single-switch fabric. Cascaded FICON directors require the use of two bytes of the standard three-byte fibre-channel link address; the third byte, for arbitrated-loop support, is not used in FICON fabrics. When using the new cascaded-FICON-director function, your hardware-I/O definitions need to be updated accordingly.

## IBM TotalStorage™ Enterprise Storage Server® (ESS) FlashCopy® Support

z/VM 4.4.0 supports the following ESS FlashCopy Version 2 enhancements:

- Data Set FlashCopy, which removes the restriction where source cylinders must be copied to the same physical target cylinders. The removal of this restriction is especially helpful when copying one VM minidisk to another. It allows a non-fullpack source minidisk to be copied to a non-fullpack target minidisk when the minidisks exist on different physical cylinder extents of the same physical volume or different physical volumes.
- Multiple Relationship FlashCopy, which allows a source to have multiple targets. This function allows one source volume to be copied to many target volumes.
- Elimination of Logical Storage System (LSS) constraint, which allows a source and target relationship to span across an LSS. This removes the restriction where both the source volume and the target volume must reside in the same logical control unit.

## ESS Long Distance Data Copy Support

z/VM 4.4.0 provides guest support for the ESS Peer-to-Peer Remote Copy Extended Distance (PPRC-XD) function. z/VM guests who support PPRC-XD and have DATAMOVER authority in their user directory can copy full volumes of data in non-synchronous mode, which extends the distance between the primary and secondary ESS with a minimal effect on performance. PPRC-XD is suitable for data migration, backup, and disaster recovery procedures. Data can be copied at distances well beyond the 103 km supported for PPRC synchronous transmissions. Typically, the distance for PPRC-XD is limited only by the capabilities of the network and channel extension technologies.

Native VM support for PPRC-XD was previously provided with the availability of Device Support Facilities (ICKDSF), Version 1 Release 17, with ICKDSF running in a CMS virtual machine.

z/VM 4.4.0 also provides guest support for PPRC Version 2, which is designed to offer an Asynchronous Cascading solution, providing a complete, consistent, and coherent copy of data at a remote site. Asynchronous Cascading provides a two-volume synchronous PPRC implementation with a non-synchronous third volume serving as a backup device that can provide a multi-site, long distance solution.

## ESS Model 800 Support

z/VM 4.4.0 supports the ESS Model 800, which provides improved performance and increased storage capacity, as well as “on the fly” configuration and management capabilities.

## IBM TotalStorage Enterprise Tape Drive 3590 Model H Support

z/VM 4.4.0 supports the new 3590 Model H tape drive. This 384-track tape drive is faster and of higher capacity than the previous 256-track 3590 Model E. The 3590 Model H can be configured to emulate the device characteristics of either the 3590 Model B or the 3490 Model E. z/VM supports both emulation modes. The drive performs at 384-track speeds and capacity regardless of how it is configured.

## Systems Management

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

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

HCD and HCM for z/VM is a new facility provided with z/VM 4.4.0 that offers a comprehensive, easy-to-use I/O-configuration management environment similar to that available with the z/OS operating system. The HCD and HCM programs work together to help you easily create and manage the hardware and software aspects of your z/VM I/O configuration.

HCM runs on a Windows-based personal computer connected to the z/VM system through TCP/IP. HCM provides an easy-to-use graphical user interface (GUI) as well as commands to help you configure your system. You provide 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. HCM provides the primary user interface to HCD, but HCD provides a backup user interface on your z/VM host for certain I/O configuration tasks and for when HCM is not available.

HCD and HCM for z/VM can be used to create and manage the hardware aspects of the I/O configuration definition for all of the LPARs in your zSeries or S/390 server. For the software aspects, HCD and HCM for z/VM creates and manages the I/O configuration definition for only the z/VM system on which it is running. The software aspects of the I/O configuration definition for operating systems in other LPARs are handled by those operating systems.

The new HCM and HCD support is an easy-to-use alternative to create and manage your I/O configuration definitions compared with z/VM's existing method of using the I/O Configuration Program (IOCP) and CP's dynamic-I/O configuration commands. The two methods are not intended to be used together, so you should choose one method or the other for your installation. For more information, see *z/VM: I/O Configuration*.

### Performance Toolkit for VM

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

- Operation of the system operator console in full-screen mode
- Management of multiple z/VM systems (local or remote)
- Post-processing of Performance Toolkit for VM history files and VM monitor data captured by the MONWRITE utility
- Viewing of performance monitor data using either Web browsers or PC-based 3270 emulator graphics
- TCP/IP performance reporting



In addition to analyzing VM performance data, the Performance Toolkit for VM processes Linux performance data obtained from the Resource Management Facility (RMF™) Linux performance gatherer, **rmfpms**. 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*.

Although the RealTime Monitor (RTM) and Performance Reporting Facility (PRF) optional features continue to be supported in z/VM 4.4.0, IBM plans to make future performance management enhancements primarily to the Performance Toolkit for VM. IBM plans that z/VM 4.4.0 will be the last release in which the RTM and PRF features will be available with z/VM, and plans to withdraw both the RTM and PRF features from marketing in a future z/VM release.

## **Automated Shutdown of the Shared File System (SFS)**

Utilizing the automated shutdown support added in z/VM 4.3.0, the CMS Shared File System (SFS) now shuts down automatically when the z/VM Control Program (CP) is shut down. Use of this function helps ease z/VM system administration and helps maintain the integrity of the SFS and its data. For more information, see *z/VM: CMS File Pool Planning, Administration, and Operation*.

## **Installation and Service Improvements**

The installation process continues to be improved in z/VM 4.4.0 by reducing the amount of system administrator input required to complete a z/VM installation. The improvements allow the service disks of the z/VM components to reside in the shared file system (SFS). Moving a component or facility into SFS directories has been automated more completely. The current practice of maintaining a complete copy of z/VM for each LPAR wastes disk space. Using SFS for installation allows sharing a single copy of source and service between LPARs and can help you reduce the DASD costs associated with installing and maintaining z/VM.

New functions preinstalled in z/VM 4.4.0 include:

- HCD and HCM for z/VM
- Performance Toolkit for VM

Language Environment is now an integrated component of z/VM.

The service process has been updated to support the removal of local modifications. Full VMSES/E message log support has been added to the SERVICE and PUT2PROD EXECs so that message logs can be viewed using the VMFVIEW command.

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## **Network Performance and Security**

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

### **TCP/IP Stack Performance**

The performance of the z/VM TCP/IP stack has been improved by optimizing additional high-use code paths and adding virtual multiprocessing capabilities. In z/VM 4.3.0, stack performance improvements focused on environments in which routing and gateway functions were the primary functions being performed. In z/VM

## New in z/VM 4.4.0

4.4.0, the enhancements concentrate on environments in which the z/VM TCP/IP stack and its clients and servers are the source of or final destination for network traffic.

### TCP/IP Stack Security

The overall security and auditability of the z/VM TCP/IP stack and the integrity of the z/VM system have been improved to aid self-protection by providing better controls, monitoring, and defaults, which include:

- Logging of all TCP/IP administrative commands (including NETSTAT, OBEYFILE, and IFCONFIG) that alter, or attempt to alter, the active IP or Control Program (CP) configuration.
- Changing the defaults of the **AssortedParms** statement within the TCP/IP configuration to:
  - **RestrictLowPorts**, to prevent impersonation (“spoofing”) of well-known z/VM TCP/IP applications by CMS users or guest operating systems
  - **VarSubnetting**, to avoid creating unnecessary TCP/IP routing table entries

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

### TCP/IP IMAP User Authentication Exit

User authentication for the z/VM TCP/IP Internet Message Access Protocol (IMAP) server can now be performed through an exit that makes use of a separate virtual machine (IMAPAUTH). This support removes prior user ID and password-length restrictions and is designed to help eliminate the need for every IMAP client to have a VM user ID and password. Instead, authentication is handled by a user-written exit routine, providing greater flexibility for choosing authentication methods. Included in the exit support is the ability to pre-authenticate connections by IP address. For more information, see *z/VM: TCP/IP Planning and Customization*.

---

## Application Enablement

This section describes new or enhanced z/VM facilities or support for application development and deployment.

### C/C++ for z/VM Compiler

IBM C/C++ for z/VM, Version 1 (5654-A22) Release 1.0, is a z/VM-enabled version of the C/C++ compiler for version 1 release 2.0 of z/OS. This new C/C++ compiler, which runs on CMS, allows C/C++ programs to be compiled and executed on CMS and creates portability between z/VM and z/OS C/C++ programs. The new OpenExtensions shell command **cxx** invokes the C/C++ for z/VM compiler. C/C++ source files can be read from a CMS minidisk, the SFS, or the byte file system (BFS), and output can be written to any of these file systems. C/C++ for z/VM runs only on z/VM 4.4.0 and can be licensed only for standard processor engines. However, applications compiled with this C/C++ compiler will run on standard processor engines or Integrated Facility for Linux (IFL) processor features. For more information, see:

- *z/VM: OpenExtensions Command Reference*
- *C/C++ for z/VM: User's Guide*, SC09-7625

### Language Environment Upgrade

To support the new C/C++ for z/VM compiler and to also provide updated run-time libraries for IBM COBOL for OS/390 & VM, Version 2 (5648-A25) Release 2.0, and

IBM PL/I for MVS & VM, Version 1 (5688-235) Release 1.1, the Language Environment run-time libraries have been upgraded to the level shipped with version 1 release 4.0 of z/OS. In addition, this new level of Language Environment has been integrated into z/VM 4.4.0 as a component. For more information, see the *z/VM: Language Environment User's Guide*.

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## Product Information

This section describes some major updates to the z/VM product information. For a list of all the updated publications, see “Editions and Formats” on page 77.

## Retitled Books

The following table lists z/VM library books that have been retitled:

Table 1. Retitled Books

Old Book Title and Number	New Book Title and Number
<i>z/VM: Dynamic I/O Configuration Planning and Administration</i> , SC24-6044	<i>z/VM: I/O Configuration</i> (form number unchanged)
<i>z/VM: Installation Guide</i> , GC24-5992	<i>z/VM: Guide for Automated Installation and Service</i> , GC24-6064

## Additions to the z/VM Library

The following books have been added to the z/VM library:

- System overview:
  - *z/VM: Glossary*, GC24-6065
- Planning and administration:
  - *z/OS and z/VM: Hardware Configuration Manager User's Guide*, SC33-7989
- Application programming:
  - *z/OS: Language Environment Concepts Guide*, SA22-7567
  - *z/OS: Language Environment Debugging Guide*, GA22-7560
  - *z/OS: Language Environment Programming Guide*, SA22-7561
  - *z/OS: Language Environment Programming Reference*, SA22-7562
  - *z/OS: Language Environment Run-Time Messages*, SA22-7566
  - *z/VM: Language Environment User's Guide*, SC24-6066
  - *z/OS: Language Environment Writing ILC Applications*, SA22-7563
  - *z/VM: Systems Management Application Programming*, SC24-6063
- Diagnosis:
  - *z/OS and z/VM: Hardware Configuration Definition Messages*, SC33-7986
- Optional features:
  - *z/VM: Performance Toolkit*, SC24-6062

## z/VM HELP Facility Enhancements

The z/VM HELP Facility has been enhanced as follows:

- Help is now provided for all TCP/IP commands and subcommands. To access TCP/IP help, enter one of the following commands:

```
help tcpip menu
help tcpip task
```

## New in z/VM 4.4.0

- Help for privileged CP commands (formerly HELP component CPOTHER) has been merged with the nonprivileged CP commands (HELP component CP). This can make it easier to display the help file for a CP command, because you do not need to know whether the command is privileged when you enter the HELP command. A menu of the help for all CP commands can be displayed by entering the following command:

```
help cp menu
```

---

## Other Changes

This section describes other enhancements and changes to z/VM.

### CP Command Response Suppression

The new CP SILENTLY command executes another CP command (ATTACH, DETACH, or GIVE) and suppresses its responses, if that command is so enabled. A command is enabled for response suppression by specifying the SILENT option on the DEFINE COMMAND / CMD or MODIFY COMMAND / CMD command or system configuration statement. For more information, see:

- *z/VM: CP Command and Utility Reference*
- *z/VM: CP Planning and Administration*

### VM Dump Tool Enhancements

The following support has been added to the VM Dump Tool:

- A new EXTRACT function for easy access from a macro environment to selected information in the dump.
- Support for a macro file type of VMDT.
- Improved support for non-CP dumps, including new subcommands/macros for migration from the Dump Viewing Facility environment (DVFSTACK, FINDSTRG, INIT, and READSTRG).
- Output from the DISPLAY subcommand, when issued from a macro, is now the same as DISPLAY subcommand output when the subcommand is issued from the command line. Any macro which depends on the output of DISPLAY will have to be modified to handle the new output.
- You can now halt long-running commands without losing unsaved dump session information by using the existing HI IMMEDIATE command. This CMS command is now supported by the following VM Dump Tool subcommands: CHAIN, FRAMES, LOCATE, TRACE, and VMDBK.
- The new XEDITPRE option of the VM Dump Tool SET subcommand allows you to disable or change the XEDIT escape value (the function that indicates when a command should be forwarded directly to XEDIT). You can reset it to either a single character or a string. This option replaces the XEDIT subcommand. Also, the new XEDITPRE option of the VM Dump Tool QUERY subcommand allows you to query the current setting for the XEDIT escape value.

For more information, see *z/VM: VM Dump Tool*.

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## Chapter 3. Technical Information

This chapter identifies the hardware and software (program) requirements of the z/VM base product and its optional features. This chapter also includes packaging and ordering information and discusses product restrictions and security. It contains the following sections:

- “Hardware Requirements”
- “Device Support” on page 22
- “Program Requirements” on page 22
- “Operating Systems Supported as Guests” on page 29
- “Other Programs Supported on z/VM” on page 29
- “National Language Support” on page 29
- “Packaging and Ordering Information” on page 29
- “Object Code Only and Limited Source Availability” on page 31
- “Restrictions” on page 31
- “Integrity and Security” on page 32

**Note:** Some technical information may have changed since this book was published. For the latest updates, you should contact your IBM Support Center or visit the z/VM Web site at <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. It includes the following topics:

- “Server Requirements”
- “Installation Requirements”
- “Minimum Storage Requirements” on page 20
- “CSE Hardware Requirements” on page 20
- “OSA/SF Hardware Requirements” on page 20
- “TCP/IP Hardware Requirements” on page 21
- “VM Guest RSA-Assist Support for Linux Hardware Requirements” on page 21

### Server Requirements

z/VM 4.4.0 requires a server capable of running z/Architecture or ESA/390 architecture. See Appendix A, “IBM Servers Supported by z/VM”, on page 83.

Specific server facilities are also required. For more information, see <http://www.ibm.com/eserver/zseries/zvm/zvm440/architecture/>.

### Installation Requirements

Installation of z/VM 4.4.0 requires the following:

- Installation requires a local non-SNA 3270 terminal, integrated 3270 console, or equivalent.

**Note:** Using an integrated 3270 console may require additional hardware support. See Appendix A, “IBM Servers Supported by z/VM”, on page 83.

## Technical Information

- Installation from magnetic tape requires a tape drive capable of reading IBM 3480 or 3590 tape cartridges.
  - Installation from CD-ROM requires one of the following:
    - IBM S/390 Multiprise® 3000 Enterprise Server
    - Optical Media Attach/2 Program (5621-264)
- Note:** This product has been withdrawn from marketing.
- 2074 Console Support Controller capable of reading Optical Media Attach format
  - Only IBM 3390 Model 1, 2, or 3 DASD, or equivalent, are supported for installation, and all 3390s must be the same model. 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 8MB, and z/VM requires at least 8MB 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 20MB. If you use CMS as a named saved system (NSS), your virtual machine size must be at least 2MB, 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 count-key-data (CKD) 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 server and OSA type, refer to one or more of the following:

- *S/390: Planning for the S/390 Open Systems Adapter (OSA-1, OSA-2) Feature*
- *S/390: Open Systems Adapter-Express Customer's Guide and Reference*

- *eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature*
- *eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*
- *eServer zSeries 990: 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 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, see 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, z/OS, or OS/390 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, z/OS, or OS/390 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, z/OS, or OS/390 using the IBM FICON Channel-to-Channel Adapter.

- IBM HiperSockets

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 for zSeries and one of the following are required:

- IBM PCI Cryptographic Coprocessor (PCICC)
- IBM PCI Cryptographic Accelerator (PCICA)

### 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 91. 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 91, 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 91, 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. It includes the following topics:

- “Current Levels of z/VM Components, Facilities, and Features” on page 23
- “Prerequisite Licensed Programs” on page 23
- “Tasks that Require the High Level Assembler” on page 23
- “CSE Program Requirements” on page 24



- “OpenExtensions Program Requirements” on page 25
- “DFSMS/VM Program Requirements” on page 24
- “Language Environment Program Requirements” on page 25
- “OSA/SF Program Requirements” on page 26
- “TCP/IP Program Requirements” on page 27
- “DirMaint Program Requirements” on page 25
- “PRF Program Requirements” on page 26
- “RTM Program Requirements” on page 27
- “RACF Program Requirements” on page 26
- “Program Requirements for VM Related Products” on page 28
- “Program Requirements for Online Books” on page 28

### Current Levels of z/VM Components, Facilities, and Features

The following list shows the levels of components and facilities included in the z/VM 4.4.0 base and the current levels of the z/VM optional features. In most cases, these specific levels are required to support z/VM 4.4.0 functions. Additional APARs may also be required. See the program requirements identified in this chapter.

- CMS Level 20
- TCP/IP for z/VM, Level 440
- DFSMS/VM, Function Level 221
- HCD and HCM for z/VM, Function Level 440
- Language Environment run-time library level equivalent to z/OS V1R4.0
- OSA/SF 4.4.0
- DirMaint, Function Level 410
- Performance Toolkit for VM, Function Level 440
- PRF, Function Level 410
- RTM, Function Level 410
- RACF for z/VM, Version 1 Release 10.0

### Prerequisite Licensed Programs

z/VM 4.4.0 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 DDR 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 for:

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- Creating a new DMSTRT for system languages (NLS)
- Creating image libraries for system printers (FCBs)
- Creating GCS application segments (CONTENTS macro)
- Accessing major CMS application interfaces (CMSCALL)
- Accessing most CP application interfaces (DIAGNOSE)
- Modifying the AVS tuning control module (AGWTUN)
- Using RAS tools such as MDCHECK, FS2SFSE, AFTCHAIN, PRINTBLK, PRINTFST, and so on
- Using the API for data compression
- Using the CMS pipelines assembler macro interface
- Customizing Language Environment or compiling assembler routines used in mixed-language user applications
- Using exit routines in z/VM features, such as in DirMaint, or VM-related products, such as RSCS
- Release 3.0 or later is required for:
  - Running applications that exploit the IEEE Floating Point hardware facility
- Release 4.0 or later is required for:
  - Adding devices that cannot be sensed (updating HCPRIO ASSEMBLE)
  - Performing local modifications to modules written in assembler
  - Servicing the CP Loader (HCPLDR)
  - Creating the Stand-Alone Dump Utility (HCPSADMP EXEC)
  - Assembling any CP modules
  - Using CP exit routines
  - Assembling RealTime Monitor after applying corrective service to CP or RealTime Monitor
  - Applying and assembling updates to CP replacement parts for RACF for z/VM

## CSE Program Requirements

The following are required to support the CSE function:

- For shared directory:
  - Directory Maintenance Facility, Function Level 410

**Note:** All systems in the CSE complex must be running the same level of DirMaint. Therefore, when running z/VM 4.4.0 on one system in the complex, you must be licensed for Directory Maintenance Facility, Function Level 410, on that system. However, if you are coupling with VM/ESA or z/VM 3.1.0 systems, you must be licensed for Directory Maintenance VM/ESA, Version 1 (5748-XE4) Release 5.0, on those systems to share and run the program code for Directory Maintenance Facility, Function Level 410.

- 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 410
- If an external security manager is needed:
  - RACF for z/VM, or an equivalent product
- To use the Migration Level 2 (ML2) function:
  - ADSTAR Distributed Storage Manager (5648-020), Tivoli ADSM for VM (5697-VM3), or Tivoli Storage Manager for VM (5697-TSM, 5697-TS9, or 5698-TSM)
  - 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 440
- 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)

The following DFSMS/VM APAR is also required:

- APAR VM63004 is required to support 3390 volumes greater than 10017 cylinders on the IBM TotalStorage Enterprise Storage Server™ (ESS).

## DirMaint Program Requirements

The Directory Maintenance Facility, Function Level 410, requires the following APARs:

- APAR VM62933 is required to support the directory changes for guest RSA-Assist support for Linux.
- APAR VM62907 is required to support 3390 volumes greater than 10017 cylinders on the Enterprise Storage Server.
- APAR VM63033 is required to support the directory changes in z/VM 4.3.0.
- APARs VM63122 and VM63251 are required to support the directory changes in z/VM 4.4.0.

The PTFs for these APARs are available as service on the stacked RSU provided with z/VM 4.4.0.

## 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

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- 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 can be accessed by a CMS user ID, a REXX call to the OSA/SF API, or the Java-based OSA/SF graphical user interface (GUI).

Access through the OSA/SF GUI requires the following:

- TCP/IP for z/VM, Level 440, on the host
- TCP/IP on the workstation
- Access to the Java 1.4 runtime and help on the workstation

To support an OSA in its TCP/IP Passthru mode in a z/VM 4.4.0 environment, OSA/SF requires TCP/IP for z/VM, Level 440. 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, see one or more of the following:

- *VM/ESA: Open Systems Adapter Support Facility User's Guide for OSA-2*
- *S/390: Open Systems Adapter-Express Customer's Guide and Reference*
- *eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*
- *eServer zSeries 990: Open Systems Adapter-Express Customer's Guide and Reference*

## PRF Program Requirements

The Performance Reporting Facility, Function Level 410, requires APAR VM63032 to support the monitor records added in z/VM 4.2.0 and z/VM 4.3.0. The PTF for this APAR is available as service on the stacked RSU provided with z/VM 4.4.0. There is no PRF update for z/VM 4.4.0.

## RACF Program Requirements

To apply and assemble updates to 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*.

## RTM Program Requirements

The RealTime Monitor, Function Level 410, requires APAR GC05481 to support the CP control blocks updated in z/VM 4.3.0. The PTF for this APAR is available as service on the stacked RSU provided with z/VM 4.4.0. There is no RTM update for z/VM 4.4.0.

To reassemble RTM after applying corrective service to CP or RTM, you need the following licensed program:

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

## TCP/IP Program Requirements

TCP/IP for z/VM, Level 440, requires the CP, CMS, and Language Environment components supplied with z/VM 4.4.0. Previous levels of CP, CMS, and Language Environment cannot be used.

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
  - SeSE Linux 2.4.19 SLES 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++ 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 programs in Pascal:
  - IBM VS Pascal, Version 1 (5668-767) Release 2, Compiler and Library

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

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### Program Requirements for Online Books

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 Acrobat Reader is required. You can also use the Adobe Acrobat Reader to print PDF books or sections of PDF books. The Adobe Acrobat Reader is available free from the Adobe Web site at <http://www.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, 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: VM Collection* CD-ROM supplied with z/VM.

### Program Requirements for VM Related Products

The following VM-related products require the specified APARs to run on z/VM 4.4.0:

- Pass-Through Facility (PVM), Version 2 (5684-100) Release 1.1, requires APAR VM61373. The PTF for this APAR has been applied as service to PVM within the SDO.
- Host Management Facility (HMF), Version 1 (5684-157) Release 1.1, requires APAR VM62632. The PTF for this APAR has been applied as service to HMF within the SDO.

### Program Requirements for Linux

Linux for S/390 or Linux for 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 for zSeries is required for specific functions to work correctly in a z/VM environment. Function planned to be available in a future distribution of Linux for zSeries includes:

- Automatic Shutdown support to handle system deactivation events and cause orderly shutdown of guests

Support provided in the SuSE SLES 8 distribution includes:

- FCP support for SCSI devices using a Fibre Channel interface

For the most current information on Linux distributions, see <http://www.ibm.com/eserver/zseries/os/linux/dist.html>.

## 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 87.

## Other Programs Supported on z/VM

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

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

## 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 2. 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>• DFSMS/VM panels and messages</li> <li>• REXX/VM messages, HELP for REXX/VM statements and messages</li> <li>• DirMaint messages</li> </ul>

## Packaging and Ordering Information

To order z/VM 4.4.0 and its features (as well as other licensed products that run on z/VM), order the z/VM Version 4 System Delivery Offering (SDO), program number 5739-A04. The z/VM SDO package contains:

- z/VM 4.4.0 System DDR
- z/VM SDO Optional Products Enabling Aid
- z/VM SDO licensed products

## Technical Information

For more information about the z/VM SDO, see <http://www.ibm.com/eserver/zseries/zvm/sdo/>.

z/VM is distributed as a multivolume system DASD dump restore (DDR) image for 3390 DASD (or devices that emulate the 3390; for the devices supported for installation, see “Direct Access Storage Devices (DASD)” on page 92). The system DDR image is available on 3480, 3490, or 3590 tape cartridges or CD-ROM disks.

The z/VM 4.4.0 System DDR 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 for VM
  - PRF
  - RTM
  - RACF for z/VM
- Selected related licensed products:
  - 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
  - Tivoli Storage Manager for VM, Version 4 (5698-TSM) Release 1.0

### Notes:

1. The DirMaint, Performance Toolkit for VM, PRF, RTM, and RACF for z/VM optional features are shipped on the z/VM System DDR 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.
2. ICKDSF, EREP/VM, RSCS, and Tivoli Storage Manager for VM are not part of z/VM. They are separate IBM licensed programs that are shipped on the z/VM System DDR for convenience. ICKDSF and EREP/VM are prerequisites of z/VM. RSCS and Tivoli Storage Manager are installed disabled. Before using any of these programs you must already be licensed for them, or you must place orders for them to establish licenses and, in the case of RSCS and Tivoli Storage Manager for VM, so that you can enable them.



If you order z/VM on tape, the base product ships with the following additional feature tapes (on the product medium):

- DFSMS/VM
- PLX source
- Stacked recommended service upgrade (RSU)

The following feature tape is separately-orderable:

- Restricted source

If you order z/VM on CD-ROM, all of the items listed above are included.

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

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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## Restrictions

z/VM does not support 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 one of the following is true:
  - The virtual machine uses the V=R performance option
  - The channel program modification facility that the DIAGNOSE interface provides can be used to ensure correct operation of such channel programs.
- Channel command support is limited to basic device support; therefore, z/VM does not support the Speed Matching Buffer. Performance degradation occurs when a DASD attached to a 3880 Control Unit with a Speed Matching Buffer is used as a CP-owned device in low speed mode.
- If operating systems running in virtual machines under z/VM control use separate master and logon consoles, the consoles should be placed on different control units; otherwise, console lockout may occur.
- When CP is running in a logical partition, you cannot run V=F guests. (They are converted into V=V guests during logon.)
- 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).

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### DirMaint Restrictions

The following restrictions apply to Directory Maintenance Facility, Function Level 410:

- 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 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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## 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" 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.

## Technical Information

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
- 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 for z/VM 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.

### Support for Cryptographic Facilities on IBM Servers

z/VM provides the following support for the cryptographic facilities provided by IBM servers:

- The CMOS Cryptographic Processor is supported for use by guests.

- The PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux 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:

## Technical Information

- 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 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 the SPXTAPE and SPTAPE 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 4. z/VM Base Product

This chapter describes the components and facilities included in the z/VM base product:

- “Control Program”
- “Conversational Monitor System” on page 44
- “TCP/IP for z/VM” on page 49
- “APPC/VM VTAM Support” on page 51
- “Data Facility Storage Management Subsystem for VM” on page 52
- “Dump Viewing Facility” on page 52
- “Group Control System” on page 53
- “Hardware Configuration Definition and Hardware Configuration Manager for z/VM” on page 53
- “Language Environment” on page 53
- “Open Systems Adapter Support Facility” on page 54
- “REXX/VM” on page 54
- “Transparent Services Access Facility” on page 54
- “Virtual Machine Serviceability Enhancements Staged/Extended” on page 55

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### Control Program

The z/VM 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.

### CP Images

z/VM provides both a 64-bit CP image and a 32-bit CP image. You can IPL a 64-bit CP image only on a z/Architecture server. You can IPL a 32-bit CP image on a z/Architecture server or on an ESA/390 architecture server.

z/VM also provides a dual-image CP. If the dual-image CP is installed, it automatically determines at IPL if the server is capable of running z/Architecture. If it is, a 64-bit CP image is loaded; otherwise, a 32-bit CP image is loaded. However, this can be overridden on the IPL to load a 32-bit CP image on a z/Architecture server.

## Base Product

# Virtual Machines

A virtual machine is defined by its architecture (virtual machine mode) and its storage configuration (virtual machine type).

### Virtual Machine Modes

z/VM supports ESA, XA, and XC mode virtual machines:

- ESA virtual machines process according to ESA/390 architecture and may also be capable of processing according to z/Architecture, depending on the server on which z/VM is installed and the CP image that is loaded.
- XA virtual machines are functionally equivalent to ESA virtual machines. The XA designation is supported for compatibility with previous versions of VM.
- XC virtual machines process according to ESA/XC architecture.

**Note:** z/VM Version 4 does not support 370-mode (System/370™ architecture) virtual machines. However, the 370 Accommodation Facility allows many CMS applications 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*.

Table 3 shows the different virtual machine designations and their resulting architecture modes on ESA/390 architecture and z/Architecture servers.

Table 3. Virtual Machine Architecture Modes

Virtual Machine Designation	Resulting Virtual Machine Architecture on an ESA/390 Server	Resulting Virtual Machine Architecture on a z/Architecture Server
ESA, XA <sup>1</sup>	ESA/390	ESA/390 or z/Architecture <sup>2</sup>
XC	ESA/XC	ESA/XC

**Notes:**

1. The XA designation is supported for compatibility. An XA virtual machine is functionally equivalent to an ESA virtual machine. However, some CMS applications may check the virtual machine designation and may require CMS to be running in an XA virtual machine.
2. An ESA virtual machine processes according to ESA/390 architecture on a 32-bit CP image on a z/Architecture server. On a 64-bit CP image on a z/Architecture server, an ESA virtual machine is capable of processing according to either ESA/390 architecture (390-mode) or z/Architecture (z-mode), as determined by the program that is loaded into the virtual machine.

### Virtual Machine Types

z/VM provides three types of virtual machines, as defined by their storage configurations:

#### V=R machine

Virtual=Real machine. This virtual machine has a fixed, contiguous area of host real storage starting at location 0. CP does not page this storage, so guest real storage maps to host real storage. CP provides performance benefits for this virtual machine (compared to V=V machines) and an automatic recovery mechanism.

#### V=F machine

Virtual=Fixed machine. This virtual machine also has a fixed, contiguous area of host real storage, but the area does not start at real location 0. CP



does not page this storage, so guest real storage maps to host real storage. CP also provides performance benefits for this virtual machine (compared to V=V machines).

**V=V machine**

Virtual=Virtual machine. This virtual machine's guest real storage does not permanently map to host real storage. Rather, CP pages the guest real storage of a V=V machine into and out of host real storage.

Because V=R and V=F machines receive preference in terms of storage and performance, these virtual machines are called preferred virtual machines.

For more information about the types of virtual machines, see *z/VM: Running Guest Operating Systems*.

## Guest Architecture Support

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 ESA/370 or 370-XA guests can run in ESA/390 virtual machines. CP does not distinguish between the 370-XA, ESA/370, and ESA/390 architectures.

If z/VM is installed on a z/Architecture server, and a 64-bit CP image is loaded, z/Architecture guests can use z/Architecture facilities such as 64-bit arithmetic and addressing.

## ESA/XC Architecture

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 basic-mode or 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 multiple z/VM systems to be coupled together in a complex that provides cross-system functions:

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

## Guest LAN

z/VM supports a network of virtual adapters connecting guests within a z/VM system. CP provides support for:

- Virtual adapters

## Base Product

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 switch to an associated real LAN connected by an OSA-Express QDIO adapter. This capability allows connectivity to external LAN segments without requiring a router.

For more information, see *z/VM: Virtual Machine Operation*.

## Inter-System Facility for Communications

The Inter-System Facility for Communications (ISFC) enables 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 stand-alone dumps, CP ABEND dumps, and virtual machine dumps of a CP system. For more information, see *z/VM: VM Dump Tool*.

**Note:** The Dump Viewing Facility interactively diagnoses virtual machine dumps. See “Dump Viewing Facility” on page 52.

## Support for Hardware Architectures and Facilities

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

**Note:** Support for some functions may depend on hardware level or availability. For more information, see:

- Chapter 2, “New Functions, Enhancements, and Other Changes”, on page 7
- Appendix A, “IBM Servers Supported by z/VM”, on page 83
- Appendix C, “IBM Devices Supported by z/VM”, on page 91

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

### Asynchronous Data Mover Facility

CP provides guest support for the Asynchronous Data Mover Facility (ADMF). ADMF provides an extension to the existing channel subsystem which is capable of

off-loading page move activity onto the I/O processor, freeing the instruction processor for other work while the page movement is performed. No external control or intervention is necessary. ADMF is available for guest use automatically at LOGON if all of the following conditions are true:

- The PR/SM™ feature is available on the server
- z/VM is running in basic mode (not in an LPAR)
- The guest is a preferred guest (V=R, V=F)

### **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 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 Facility**

CP supports guest use of a cryptographic facility. The cryptographic facility provides cryptographic capability to transaction processing environments. Cryptography is an effective means of protecting data in computer and communication systems from unauthorized disclosure. It involves the process of transforming plaintext into ciphertext (encipherment) and the reverse process of transforming ciphertext into plaintext (decipherment).

### **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 multi-site, 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 4KB blocks between itself and real storage.

### **Extended Channel Measurement Data Support (ECMDS)**

CP supports the extended I/O-measurement facilities provided in the IBM @server zSeries 990 (z990). These facilities 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 provides guest support for the fibre channel protocol (FCP) hardware channel. This channel allows an IBM zSeries server to connect to a fibre-channel fabric. The CP support allows 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 and exploits existing ESCON equipment and infrastructure, but offers improved link performance and enhanced distance connectivity. Each FICON channel provides the equivalent of eight ESCON channels.

### **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 an IBM zSeries server (at the appropriate service level) and another zSeries server or an S/390 Parallel Enterprise Server™ G5 or G6. 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.

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 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 and on the IBM S/390 Enterprise Server G5 and later. 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 S/390 Integrated Facility for Linux (IFL) is a hardware feature available on G5, G6, Multiprise 3000, and 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 83.

### **Logical Channel Subsystems**

The z990 server provides a logical channel subsystem (LCSS) structure, which is designed to allow the definition of more than one channel subsystem (CSS), 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 logical channel subsystems when z/VM is running on a z990 server with the applicable hardware support.

### **Move-Page Facility**

CP supports guest use of the Move-Page Facility. 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.

Move-Page support is available to all guests running in z/Architecture mode and to all guests in ESA/XC virtual machines.

When z/VM is running on a server in basic mode, Move-Page support is available to all first-level guests, as well as to all second-level guests running under a V=V z/VM guest.

When z/VM is running in an LPAR or as a V=R or V=F guest of a z/VM system running on a server in basic mode, Move-Page support is *not* available to its ESA/390 guests. Move-Page support is still available to its z/Architecture and ESA/XC guests.

### **Open Systems Adapter**

CP supports guest use of the Open Systems Adapter-2 (OSA-2) and Open Systems Adapter-Express (OSA-Express) hardware features, which provide connectivity to various types of networks. For more information, see “Open Systems Adapter Support Facility” on page 54.

### PCI Cryptographic Accelerator and Coprocessor

CP supports the IBM PCI Cryptographic Accelerator (PCICA) and the IBM PCI Cryptographic Coprocessor (PCICC) for Linux guest virtual machines. This support provides clear-key RSA support for Linux guests enabling hardware SSL acceleration on zSeries and S/390 servers. A z/VM system can include Linux guests using the RSA-Assist support simultaneously with other guests using the CMOS cryptographic support.

### Processor Resource/Systems Manager™

On processors with the Processor Resource/Systems Manager (PR/SM) feature installed, CP supports both basic mode and logically partitioned (LPAR) mode.

**PR/SM Support of Multiple Preferred Guests:** When the processor operates in basic mode, CP supports up to six preferred guests. Two configurations are supported: one V=R guest and up to five V=F guests, or no V=R guest and up to six V=F guests. On a physically partitioned multiprocessor, each copy of z/VM supports up to six preferred guests.

With multiple preferred guest support, you can simultaneously support many CMS users, test multiple guest systems, and support multiple production 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 running on a z/Architecture or ESA/390 processor 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 server, adapter interruptions are also used by OSA-Express and FCP channels.

The z990 is also designed to 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.

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## 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.
- 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 52.

## 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*.

## Base Product

### 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++ run-time 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++ run-time 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 an interactive environment in support of the POSIX application environment and tools that aid in program development and in porting applications from other open systems. The shell provides a UNIX-like interactive user environment. Users of the shell environment have access to both the shell commands set (built-in commands and utilities) and the full CP and CMS command set, 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 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*
- *OS/390: DFSMS Program Management*

## 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 are heavily exploitive of 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.

## Base Product

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

## System Administration Facility

The System Administration Facility provides tools to help you create and manage multiple Linux images on a single z/VM platform. You can allocate resources among multiple Linux servers running on z/VM, and z/VM will manage the assignment of portions of hardware to each individual Linux image. A client program that runs on a Linux image or on CMS sends system management commands to the System Administration Facility server. The System Administration Facility includes commands for creating Linux images, assigning disk partitions, querying, starting and stopping Linux images, and performing other control functions. The tools are based on some of the ease-of-use functions that were part of the S/390 Virtual Image Facility™ for Linux (VIF) product. The System Administration Facility includes a migration facility that you can use to migrate existing VIF configurations to a z/VM system. For more information, see *z/VM: System Administration Facility*.

## 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*.

## z/VM HELP Facility

The z/VM 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 z/VM HELP Facility. You can also write your own HELP information. For more information, see the *z/VM: CMS User's Guide*.

## TCP/IP for z/VM

TCP/IP for z/VM brings the power and resources of your IBM zSeries or S/390 server to the internet. Using the TCP/IP protocol suite of TCP/IP for z/VM, you can reach open multivendor 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, 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.

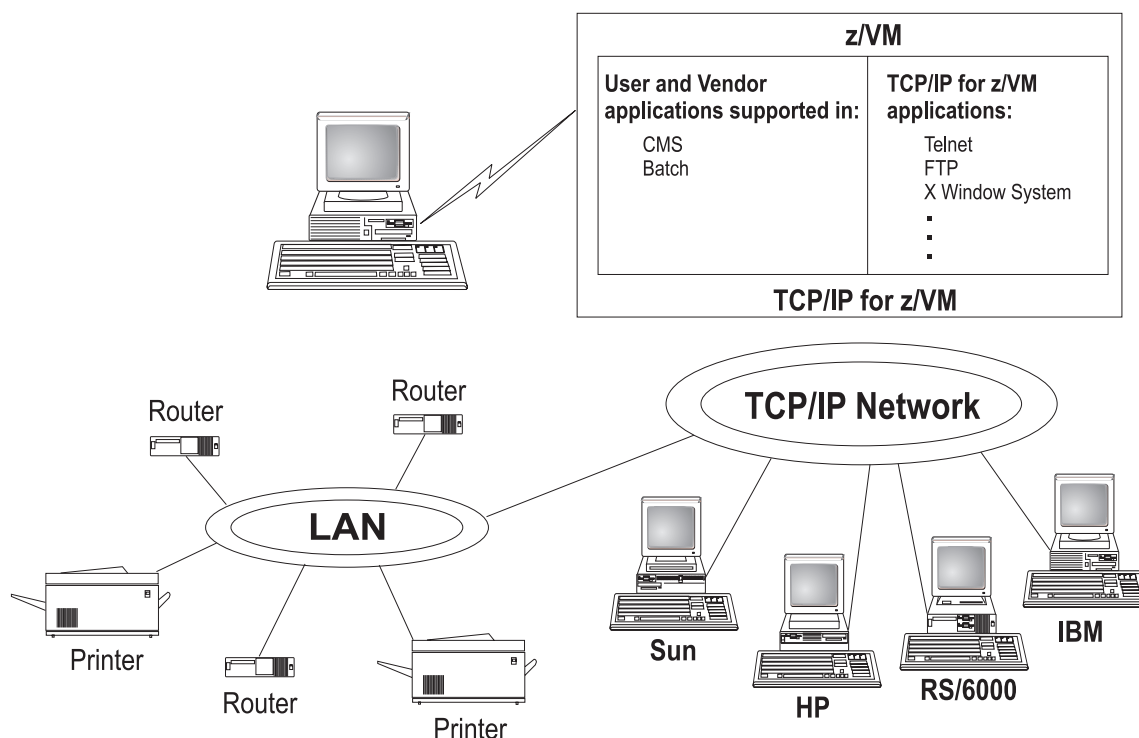


Figure 1. TCP/IP for z/VM as Part of a Multivendor Network

## Base Product

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 internetwork layer provide connection services for TCP/IP. These protocols connect physical networks and transport protocols. The network protocols are 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.

## 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 resends 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.
- **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

## Base Product

- APPC applications residing in non-VM systems in the SNA network

For more information, see *VM/ESA: Connectivity Planning, Administration, and Operation*.

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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 Function Level 221 Planning Guide*.

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## Dump Viewing Facility

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

**Note:** Analysis of CP stand-alone dumps, CP ABEND dumps, and virtual machine dumps of a CP system, functions formerly performed by the Dump Viewing Facility, are now performed by the VM Dump Tool. See “VM Dump Tool” on page 40.

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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 and Hardware Configuration Manager for z/VM (HCD and 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 or S/390 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 or S/390 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 run-time 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 Product

- 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 run-time 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) and Open Systems Adapter-Express (OSA-Express) are integrated hardware features that allow zSeries and S/390 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 (depending on your server and OSA type):

- *S/390: Open Systems Adapter-Express Customer's Guide and Reference*
- *S/390: Open Systems Adapter-Express Customer's Guide and Reference*
- *eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*
- *eServer zSeries 990: 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 *VM/ESA: Connectivity Planning, Administration, and Operation*.

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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 also helps 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 5. z/VM Optional Features

This chapter describes the optional features of z/VM:

- “Directory Maintenance Facility”
- “Performance Reporting Facility” on page 58
- “Performance Toolkit for VM” on page 58
- “RealTime Monitor” on page 59
- “Resource Access Control Facility for z/VM” on page 59

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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:

- 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.

## Optional Features

- 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 32
- “DirMaint System Integrity” on page 34
- “DirMaint Security” on page 35
- *z/VM: Directory Maintenance Facility Tailoring and Administration Guide*

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## Performance Reporting Facility

The Performance Reporting Facility (PRF) simplifies performance analysis and resource management on your z/VM system. It analyzes your system’s monitor data and produces performance reports and history files, including:

- System resource utilization, transaction response time, and throughput
- Resource utilization by user ID
- DASD activity and channel utilization

PRF provides a command interface for starting the program and setting parameters for generating the reports and records. It also provides mapping macros for the history files. For more information, see *z/VM: Performance Reporting Facility Function Level 410*.

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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 for VM 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 <http://www.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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## RealTime Monitor

The RealTime Monitor (RTM) is a monitor and diagnostic tool for system monitoring, analysis, and problem-solving. RTM monitors system performance and the use of system resources. It can also be used for installations of hardware and software to assist in validating the system components and establishing requirements for additional hardware or software.

RTM provides both a command interface and an application program interface (API). Monitor data can be displayed at the RTM virtual machine console or sent to the spooling subsystem. For more information, see *z/VM: RealTime Monitor Function Level 410*.

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## Resource Access Control Facility for z/VM

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

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

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

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

In addition to defining user and group authorities, RACF protects resources. You can protect system resources and user resources. System resources include system minidisks, system SFS files and directories, certain VM events, and terminals. User resources include user minidisks and user SFS files and directories.

RACF stores all this information about users, groups, and resources in profiles. A profile is a record of RACF information that has been defined by the security administrator. There are user, group, and resource profiles. Using the information in its profiles, RACF authorizes access to certain resources. RACF applies user attributes, group authorities, and resource authorities to control use of the system. The security administrator or someone in authority in your organization controls the information in your user profile, in group profiles, and in resource profiles. You, as

## Optional Features

an end user, control the information in profiles describing your own resources, such as your own minidisks. You can protect your data by setting up resource profiles. You can set up an access list in your resource profile to control who has read-access and who has write-access to your data.

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

For more information, see *Resource Access Control Facility: General Information*.

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## Chapter 6. z/VM Library Guide

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

- “z/VM Internet Library”
- “z/VM Publications CD-ROM”
- “Basic (Automatically Shipped) z/VM Documentation” on page 62
- “z/VM Base Library” on page 62
- “Books for z/VM Optional Features” on page 75
- “Editions and Formats” on page 77

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### z/VM Internet Library

The z/VM Internet Library, <http://www.ibm.com/eserver/zseries/zvm/library/>, provides access to z/VM product publications in Adobe Portable Document Format (PDF) and IBM BookManager format. The z/VM Internet Library also provides access to other information about z/VM, such as:

- Program directories
- CP and CMS data areas and control blocks
- Monitor records
- IBM Redbooks™
- White papers, consultant reports, and performance reports
- Specification sheets
- Reference guides
- Marketing brochures
- Journals and bulletins

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### z/VM Publications CD-ROM

The *IBM eServer zSeries Online Library: VM Collection*, SK2T-2067, contains libraries in BookManager format for current IBM z/VM system products and IBM licensed products that run on z/VM. It also contains PDF versions of many of these books.

**Note:** Only unlicensed books are included.

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

- One copy of the *VM Collection* CD-ROM
- One printed copy of each of the following z/VM base library books:
  - *z/VM: License Information*
  - *z/VM: Guide for Automated Installation and Service*
  - *z/VM: TCP/IP Planning and Customization*
- A complete set of z/VM HELP files

**Note:** For any book included on the *VM Collection* CD-ROM or provided in printed format with z/VM, a later edition may be available from the z/VM Internet Library or the IBM Publications Center.

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### z/VM Base Library

The base library contains books that describe the components and facilities included in the z/VM base product. This section provides a brief abstract for each book in the base library. The books are listed under the following general task categories:

- “System Overview”
- “Installation and Service” on page 63
- “Planning and Administration” on page 64
- “Customization” on page 67
- “Operation” on page 67
- “Application Programming” on page 68
- “End Use” on page 72
- “Diagnosis” on page 73

The title of the book is followed by the publication number. For information about the current edition levels and available formats of these books, see “Editions and Formats” on page 77.

### System Overview

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

#### **z/VM: General Information, GC24-5991**

*z/VM: General Information* provides general information about z/VM. It contains:

- An introduction to z/VM
- An overview of the functions that are new or changed in the current release
- Hardware and software requirements and packaging information
- Descriptions of the z/VM components, facilities, and optional features
- A library guide that describes the product documentation
- A list of the IBM processors that z/VM supports
- A list of the IBM operating systems supported as guests of z/VM
- A list of the IBM devices that z/VM supports

#### **z/VM: Glossary, GC24-6065**

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



**z/VM: License Information, GC24-6033**

*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, GC24-5996**

The *z/VM: Migration Guide* provides information to help system support personnel migrate to the new z/VM release from a VM/ESA 2.1.0 or later 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 since VM/ESA 2.1.0 that you should be aware of before migrating
- Identification of external interfaces that have changed in each release since VM/ESA 2.1.0
- Guidance for some migration tasks you might need to perform

**Note:** For migrations from releases prior to VM/ESA 2.1.0, this book indicates what other books (not included in the z/VM library) that you should obtain for additional information.

## 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, GC24-6064**

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 packaged in DASD Dump Restore (DDR) image format. 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 is the *z/VM: Summary for Automated Installation and Service*, a separate card that contains streamlined installation and service procedures.

**z/VM: Service Guide, GC24-5993**

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, GC24-5994**

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, SC24-6058**

*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 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 start-up parameters and file pool administration and server commands.

#### **z/VM: CMS Planning and Administration, SC24-6042**

*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

#### **VM/ESA: Connectivity Planning, Administration, and Operation, SC24-5756**

*VM/ESA: Connectivity Planning, Administration, and Operation* describes the z/VM components and facilities that enable communications between programs that run on VM and non-VM systems. This book presents basic connectivity concepts and planning considerations. It also provides information to help you use the Transparent Services Access Facility (TSAF), APPC/VM VTAM Support (AVS), and Inter-System Facility for Communications (ISFC) on your VM system.

#### **z/VM: CP Planning and Administration, SC24-6043**

*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: DFSMS/VM Function Level 221 Planning Guide, SC24-6049**

The *z/VM: DFSMS/VM Function Level 221 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 Function Level 221 Removable Media Services, SC24-6050**

*z/VM: DFSMS/VM Function Level 221 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 Function Level 221 Storage Administration, SC24-6051**

*z/VM: DFSMS/VM Function Level 221 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.

**z/VM: Group Control System, SC24-5998**

*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/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.

**z/VM: I/O Configuration, SC24-6044**

*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.

**VM/ESA: Open Systems Adapter Support Facility User's Guide for OSA-2, SC28-1992**

The *VM/ESA: Open Systems Adapter Support Facility User's Guide for OSA-2* provides step-by-step instructions for setting up and using the Open Systems Adapter Facility (OSA/SF) on VM to configure and manage OSA-2 features.

**S/390: Open Systems Adapter-Express Customer's Guide and Reference, SA22-7403**

The *S/390: 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 S/390 servers.

### **eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference, SA22-7476**

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 z800 and z900 servers.

### **eServer zSeries 990: Open Systems Adapter-Express Customer's Guide and Reference, SA22-7935**

The *eServer zSeries 990: 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 the z990 server.

### **z/VM: Performance, SC24-5999**

*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.

### **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.

### **S/390: Planning for the S/390 Open Systems Adapter (OSA-1, OSA-2) Feature, GC23-3870**

*S/390: Planning for the S/390 Open Systems Adapter (OSA-1, OSA-2) Feature* provides information to help you plan for, install, and use the Open Systems Adapter (OSA) hardware feature on an S/390 server.

### **z/VM: Running Guest Operating Systems, SC24-5997**

*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 VSE, MVS™, VM, or Linux in a virtual machine.

### **z/VM: Saved Segments Planning and Administration, SC24-6056**

*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: System Administration Facility, SC24-6034**

*z/VM: System Administration Facility* describes how to plan for and use the tools provided by the z/VM System Administration Facility to help you create and manage multiple Linux images on a single z/VM platform. Using these tools, you will be able to allocate resources among multiple Linux servers running on z/VM. z/VM will manage the assignment of portions of hardware to each individual Linux image. A client program that runs either on a Linux image or as a CMS client sends system management commands to the System Administration Facility server. These commands create Linux images; assign disk partitions; query, start and stop Linux images; and perform other control functions.

The System Administration Facility tools are based on some of the ease-of-use functions that were part of the IBM S/390 Virtual Image Facility for Linux (VIF) product. This book also describes a migration facility that you can use to migrate existing VIF configurations to a z/VM system.

### **z/VM: TCP/IP Planning and Customization, SC24-6019**

*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.

## **Customization**

The following books provide information about extending or enhancing a z/VM system.

### **z/VM: CP Exit Customization, SC24-5933**

*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

### **z/VM: DFSMS/VM Function Level 221 Customization, SC24-6047**

*z/VM: DFSMS/VM Function Level 221 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

## **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, SC24-6000**

*z/VM: System Operation* explains how to operate z/VM on an IBM zSeries or S/390 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, SC24-6036**

*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 (CP)
- Managing the storage, processor, and I/O resources of a virtual machine
- Using z/VM facilities to test programs running in a virtual machine

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### 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, SC24-6002**

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) Facility
- VM Data Space Support
- CMS libraries
- CMS Batch Facility
- Parsing Facility
- Message repositories

#### **z/VM: CMS Application Development Guide for Assembler, SC24-6003**

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, SC24-6052**

*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, SC24-6004**

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, SC24-6005**

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).

#### **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.

### **z/VM: CP Programming Services, SC24-6001**

*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

### **VM/ESA: CPI Communications User's Guide, SC24-5595**

The *VM/ESA: 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.

This book is intended for programmers who want to learn how to write communications programs but are not familiar with communications programming.

### **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 on OS/390. This book should be used in conjunction with *z/VM: Program Management Binder for CMS*.

### **z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation, SC24-5965**

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/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 run-time 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 run-time 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 run-time messages and return codes for Language Environment and supported high-level languages.

### **z/VM: Language Environment User's Guide, SC24-6066**

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/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.

### **z/VM: OpenExtensions Advanced Application Programming Tools, SC24-6067**

*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, SC24-6007**

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++ run-time library. This book also describes callable services that are not related to the standards.

### **z/VM: OpenExtensions Command Reference, SC24-6006**

The *z/VM: OpenExtensions Command 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, GC24-6068**

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, SC24-6053**

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, SC24-6057**

*z/VM: Program Management Binder for CMS* describes the differences in usage and behavior between the Program Management binder for CMS and the OS/390 DFSMS Program Management binder, as documented in *OS/390: DFSMS Program Management*. See "OS/390: DFSMS Program Management, SC27-0806" on page 69.

### **VM/ESA: Programmer's Guide to the Server-Requester Programming Interface for VM, SC24-5455**

The *VM/ESA: Programmer's Guide to the Server-Requester Programming Interface for VM* provides information on how to write and install IBM Enhanced Connectivity Facilities services in a VM system. For workstation users, the book also offers information on how to start IBM Enhanced Connectivity Facilities communications on VM.

### **z/VM: Reusable Server Kernel Programmer's Guide and Reference, SC24-5964**

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.

### **VM/ESA: REXX/VM Primer, SC24-5598**

The *VM/ESA: REXX/VM Primer* introduces programming using the REstructured eXtended eXecutor (REXX) language. This book is intended to help you get started with writing and running REXX programs, commonly called execs.

### **z/VM: REXX/VM Reference, SC24-6035**

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, SC24-5962**

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. However, users with no programming experience should read the *VM/ESA: REXX/VM Primer* before reading this book.

### **z/VM: Systems Management Application Programming, SC24-6063**

*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.

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- 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, SC24-6021**

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)

## End Use

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

### **z/VM: CMS Command and Utility Reference, SC24-6010**

The *z/VM: CMS Command and Utility 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, SC24-5971**

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, SC24-5970**

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 multistream 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

### **VM/ESA: CMS Primer, SC24-5458**

The *VM/ESA: 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 notes and files
- Using the Shared File System (SFS)

### **z/VM: CMS User's Guide, SC24-6009**

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 *VM/ESA: CMS Primer* before reading this book.

### **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.

### **z/VM: CP Command and Utility Reference, SC24-6008**

The *z/VM: CP Command and Utility Reference* provides detailed reference information on Control Program (CP) commands and system utilities for users of every privilege class.

### **z/VM: Quick Reference, SC24-6011**

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, SC24-6020**

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 Command and Macro Reference, SC24-5973**

The *z/VM: XEDIT Command and Macro 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, SC24-5972**

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.

## **Diagnosis**

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

### **z/VM: DFSMS/VM Function Level 221 Diagnosis Guide, GC24-6046**

The *z/VM: DFSMS/VM Function Level 221 Diagnosis Guide* provides information about diagnosing and reporting DFSMS/VM errors.

### **z/VM: DFSMS/VM Function Level 221 Messages and Codes, GC24-6048**

*z/VM: DFSMS/VM Function Level 221 Messages and Codes* contains explanations and suggested actions for messages and codes issued by DFSMS/VM.

### **z/VM: Diagnosis Guide, GC24-6039**

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, GC24-5966**

*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/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).

### **z/VM: System Messages and Codes - CMS, GC24-6031**

*z/VM: System Messages and Codes - CMS* describes the messages and codes generated by the CMS 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: System Messages and Codes - CP, GC24-6030**

*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: System Messages and Codes - Other Components, GC24-6032**

*z/VM: System Messages and Codes - Other Components* 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: TCP/IP Diagnosis Guide, GC24-6023**

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, GC24-6022**

*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, GC24-6037**

*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 stand-alone 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.

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## Books for z/VM Optional Features

This section describes the books for the optional features of z/VM. It provides a brief abstract for each book. The title of the book is followed by the publication number. For information about the current edition levels and available formats of these books, see “Editions and Formats” on page 77.

### Directory Maintenance Facility

**z/VM: Directory Maintenance Facility Command Reference, SC24-6025**

The *z/VM: Directory Maintenance Facility Command 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, GC24-6026**

*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, SC24-6024**

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 Reporting Facility

**z/VM: Performance Reporting Facility Function Level 410, SC24-6027**

*z/VM: Performance Reporting Facility Function Level 410* describes how to use PRF to analyze and report your system’s monitor data.

### Performance Toolkit for VM

**z/VM: Performance Toolkit, SC24-6062**

The *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

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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.

## RealTime Monitor

### **z/VM: RealTime Monitor Function Level 410, SC24-6028**

*z/VM: RealTime Monitor Function Level 410* describes how to use RTM to monitor system performance and the use of system resources.

## Resource Access Control Facility 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

**Editions and Formats**

The tables in this section identify the current edition and available formats for each book in the z/VM library. Table 4 on page 78 lists the books for the z/VM base. Table 5 on page 81 lists the books for the z/VM optional features.

The current edition of a book is indicated by its publication number suffix, which is listed in the **Edition** column of the table. If this is the first edition for z/VM Version 4, the book has a new publication number with a suffix of -00. A book that is new to the library or has a new edition for z/VM 4.4.0 is identified with the **NEW** icon. The table also indicates which z/VM books are available as Adobe PDF files, IBM BookManager files, or printed books.

**CD-ROM**

The current edition of the *IBM eServer zSeries Online Library: VM Collection* is SK2T-2067-21.

**PDF Books**

Books that are available as PDF files are indicated by "Yes" in the **PDF** column of the tables. PDF books are available from one or more of the following sources:

- *VM Collection*
- z/VM Internet Library at <http://www.ibm.com/eserver/zseries/zvm/library/>
- IBM Resource Link™ at <http://www.ibm.com/servers/resourceLink>
- IBM Publications Center at <http://www.ibm.com/shop/publications/order/>

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### BookManager Books

Books that are available in BookManager files are indicated by “Yes” in the **BookMgr** column of the tables. BookManager books are available from one or more of the following sources:

- *VM Collection*
- z/VM Internet Library at <http://www.ibm.com/eserver/zseries/zvm/library/>
- IBM Resource Link at <http://www.ibm.com/servers/resourcelink>
- IBM Publications Center at <http://www.ibm.com/shop/publications/order/>

**Note:** 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.

### Printed Books

Books that are available as printed books are indicated by either “Basic” or “Extra” in the **Printed** column of the tables. “Basic” books are supplied free with z/VM. “Extra” books are not orderable with the z/VM product, but you can order them separately for a fee from the IBM Publications Center, <http://www.ibm.com/shop/publications/order/>. If the **Printed** column is blank, there is no printed version of the current edition of the book. However, you can obtain a printed copy of the current edition by printing the PDF file.

### Base Library Books

The following table shows the current editions and available formats of the books in the z/VM base library.

Table 4. Current Editions and Available Formats of Books in the z/VM Base Library

Book Title	Number	Edition	PDF	BookMgr	Printed
z/VM: CMS Application Development Guide	SC24-6002	-01 <b>NEW</b>	Yes	Yes	
z/VM: CMS Application Development Guide for Assembler	SC24-6003	-00	Yes	Yes	
z/VM: CMS Application Multitasking	SC24-6052	-00 <b>NEW</b>	Yes	Yes	
z/VM: CMS Callable Services Reference	SC24-6004	-03 <b>NEW</b>	Yes	Yes	
z/VM: CMS Command and Utility Reference	SC24-6010	-03 <b>NEW</b>	Yes	Yes	
z/VM: CMS File Pool Planning, Administration, and Operation	SC24-6058	-00 <b>NEW</b>	Yes	Yes	
z/VM: CMS Macros and Functions Reference	SC24-6005	-00	Yes	Yes	
z/VM: CMS Pipelines Reference	SC24-5971	-00	Yes	Yes	
z/VM: CMS Pipelines User’s Guide	SC24-5970	-00	Yes	Yes	
z/VM: CMS Planning and Administration	SC24-6042	-00	Yes	Yes	
VM/ESA: CMS Primer	SC24-5458	-02		Yes	Extra
z/VM: CMS User’s Guide	SC24-6009	-01 <b>NEW</b>	Yes	Yes	
CMS/TSO Pipelines Author’s Edition	SL26-0018	-03		Yes	Extra



Table 4. Current Editions and Available Formats of Books in the z/VM Base Library (continued)

Book Title	Number	Edition	PDF	BookMgr	Printed
Common Programming Interface Communications Reference	SC26-4399	-09		Yes <sup>1</sup>	Extra
Common Programming Interface Resource Recovery Reference	SC31-6821	-01		Yes	Extra
VM/ESA: Connectivity Planning, Administration, and Operation	SC24-5756	-00		Yes	Extra
z/VM: CP Command and Utility Reference	SC24-6008	-04 <b>NEW</b>	Yes	Yes	
z/VM: CP Exit Customization	SC24-5933	-00	Yes	Yes	
z/VM: CP Planning and Administration	SC24-6043	-01 <b>NEW</b>	Yes	Yes	
z/VM: CP Programming Services	SC24-6001	-03 <b>NEW</b>	Yes	Yes	
VM/ESA: CPI Communications User's Guide	SC24-5595	-01		Yes	Extra
OS/390: DFSMS Program Management	SC27-0806	-00	Yes	Yes	Extra
z/VM: DFSMS/VM Function Level 221 Diagnosis Guide	GC24-6046	-00	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Customization	SC24-6047	-00	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Messages and Codes	GC24-6048	-00	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Planning Guide	SC24-6049	-00	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Removable Media Services	SC24-6050	-00	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Storage Administration	SC24-6051	-00	Yes	Yes	
z/VM: Diagnosis Guide	GC24-6039	-00	Yes	Yes	
z/VM: Dump Viewing Facility	GC24-5966	-00	Yes	Yes	
z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation	SC24-5965	-00	Yes	Yes	
z/VM: General Information	GC24-5991	-05 <b>NEW</b>	Yes	Yes	Extra
z/VM: Glossary	GC24-6065	-00 <b>NEW</b>	Yes	Yes	
z/VM: Group Control System	SC24-5998	-03 <b>NEW</b>	Yes	Yes	
z/VM: Guide for Automated Installation and Service <sup>2</sup>	GC24-6064	-00 <b>NEW</b>	Yes <sup>3</sup>		Basic
z/OS and z/VM: Hardware Configuration Definition Messages	SC33-7986	-03 <b>NEW</b>	Yes	Yes	Extra
z/OS and z/VM: Hardware Configuration Manager User's Guide	SC33-7989	-03 <b>NEW</b>	Yes	Yes	Extra
z/VM: I/O Configuration	SC24-6044	-01 <b>NEW</b>	Yes	Yes	
z/OS: Language Environment Concepts Guide	SA22-7567	-03 <b>NEW</b>	Yes	Yes	
z/OS: Language Environment Debugging Guide	GA22-7560	-03 <b>NEW</b>	Yes	Yes	

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Table 4. Current Editions and Available Formats of Books in the z/VM Base Library (continued)

Book Title	Number	Edition	PDF	BookMgr	Printed
z/OS: Language Environment Programming Guide	SA22-7561	-03 <b>NEW</b>	Yes	Yes	
z/OS: Language Environment Programming Reference	SA22-7562	-03 <b>NEW</b>	Yes	Yes	
z/OS: Language Environment Run-Time Messages	SA22-7566	-03 <b>NEW</b>	Yes	Yes	
z/VM: Language Environment User's Guide	SC24-6066	-00 <b>NEW</b>	Yes	Yes	
z/OS: Language Environment Writing ILC Applications	SA22-7563	-01 <b>NEW</b>	Yes	Yes	Extra
z/VM: License Information	GC24-6033	-04 <b>NEW</b>	Yes		Basic
z/VM: Migration Guide	GC24-5996	-03 <b>NEW</b>	Yes	Yes	
VM/ESA: Open Systems Adapter Support Facility User's Guide for OSA-2	SC28-1992	-03	Yes	Yes	Extra
S/390: Open Systems Adapter-Express Customer's Guide and Reference	SA22-7403	-04	Yes	Yes	Extra
eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference	SA22-7476	-03 <b>NEW</b>	Yes	Yes	
eServer zSeries 990: Open Systems Adapter-Express Customer's Guide and Reference	SA22-7935	-00 <b>NEW</b>	Yes	Yes	
z/VM: OpenExtensions Advanced Application Programming Tools	SC24-6067	-00 <b>NEW</b>	Yes	Yes	
z/VM: OpenExtensions Callable Services Reference	SC24-6007	-01 <b>NEW</b>	Yes	Yes	
z/VM: OpenExtensions Command Reference	SC24-6006	-01 <b>NEW</b>	Yes	Yes	
z/VM: OpenExtensions POSIX Conformance Document	GC24-6068	-00 <b>NEW</b>	Yes	Yes	
z/VM: OpenExtensions User's Guide	SC24-6053	-01 <b>NEW</b>	Yes	Yes	
z/VM: Performance	SC24-5999	-03 <b>NEW</b>	Yes	Yes	
eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature	GA22-7477	-00	Yes	Yes	
S/390: Planning for the S/390 Open Systems Adapter (OSA-1, OSA-2) Feature	GC23-3870	-08	Yes	Yes	Extra
z/VM: Program Management Binder for CMS	SC24-6057	-00	Yes	Yes	
VM/ESA: Programmer's Guide to the Server-Requester Programming Interface for VM	SC24-5455	-01		Yes	Extra
z/VM: Quick Reference	SC24-6011	-04 <b>NEW</b>	Yes	Yes	
z/VM: Reusable Server Kernel Programmer's Guide and Reference	SC24-5964	-00	Yes	Yes	
VM/ESA: REXX/VM Primer	SC24-5598	-01		Yes	Extra
z/VM: REXX/VM Reference	SC24-6035	-00	Yes	Yes	

Table 4. Current Editions and Available Formats of Books in the z/VM Base Library (continued)

Book Title	Number	Edition	PDF	BookMgr	Printed
z/VM: REXX/VM User's Guide	SC24-5962	-00	Yes	Yes	
z/VM: Running Guest Operating Systems	SC24-5997	-02	Yes	Yes	
z/VM: Saved Segments Planning and Administration	SC24-6056	-00	Yes	Yes	
z/VM: Service Guide	GC24-5993	-03 <b>NEW</b>	Yes	Yes	
z/VM: System Administration Facility	SC24-6034	-02 <b>NEW</b>	Yes	Yes	
z/VM: System Messages and Codes - CMS	GC24-6031	-03 <b>NEW</b>	Yes	Yes	
z/VM: System Messages and Codes - CP	GC24-6030	-04 <b>NEW</b>	Yes	Yes	
z/VM: System Messages and Codes - Other Components	GC24-6032	-03 <b>NEW</b>	Yes	Yes	
z/VM: System Operation	SC24-6000	-02 <b>NEW</b>	Yes	Yes	
z/VM: Systems Management Application Programming	SC24-6063	-00 <b>NEW</b>	Yes	Yes	
z/VM: TCP/IP Diagnosis Guide	GC24-6023	-02 <b>NEW</b>	Yes	Yes	
z/VM: TCP/IP Messages and Codes	GC24-6022	-03 <b>NEW</b>	Yes	Yes	
z/VM: TCP/IP Planning and Customization	SC24-6019	-02 <b>NEW</b>	Yes	Yes	Basic
z/VM: TCP/IP Programmer's Reference	SC24-6021	-02 <b>NEW</b>	Yes	Yes	
z/VM: TCP/IP User's Guide	SC24-6020	-02 <b>NEW</b>	Yes	Yes	
z/VM: Virtual Machine Operation	SC24-6036	-02 <b>NEW</b>	Yes	Yes	
z/VM: VM Dump Tool	GC24-6037	-01 <b>NEW</b>	Yes	Yes	
z/VM: VMSES/E Introduction and Reference	GC24-5994	-03 <b>NEW</b>	Yes	Yes	
z/VM: XEDIT Command and Macro Reference	SC24-5973	-00	Yes	Yes	
z/VM: XEDIT User's Guide	SC24-5972	-00	Yes	Yes	
<b>Notes on the Base Library:</b>					
1. The latest BookManager version of the <i>Common Programming Interface Communications Reference</i> is SC26-4399-08.					
2. Includes the z/VM: <i>Summary for Automated Installation and Service</i> card.					
3. The PDF version of the z/VM: <i>Guide for Automated Installation and Service</i> is not included on the <i>VM Collection</i> CD-ROM.					

## Books for Optional Features

The following table shows the current editions and available formats of the books for the z/VM optional features.

Table 5. Current Editions and Available Formats of Books for Optional Features

Feature / Book Title	Number	Edition	PDF	BookMgr	Print
<b>Directory Maintenance Facility</b>					
z/VM: Directory Maintenance Facility Command Reference	SC24-6025	-04 <b>NEW</b>	Yes	Yes	
z/VM: Directory Maintenance Facility Messages	GC24-6026	-04 <b>NEW</b>	Yes	Yes	

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Table 5. Current Editions and Available Formats of Books for Optional Features (continued)

Feature / Book Title	Number	Edition	PDF	BookMgr	Print
z/VM: Directory Maintenance Facility Tailoring and Administration Guide	SC24-6024	-04 <b>NEW</b>	Yes	Yes	
<b>Performance Reporting Facility</b>					
z/VM: Performance Reporting Facility Function Level 410	SC24-6027	-02	Yes	Yes	
<b>Performance Toolkit for VM</b>					
z/VM: Performance Toolkit	SC24-6062	-00 <b>NEW</b>	Yes	Yes	
<b>RealTime Monitor</b>					
z/VM: RealTime Monitor Function Level 410	SC24-6028	-02	Yes	Yes	
<b>Resource Access Control Facility for z/VM</b>					
Resource Access Control Facility: Auditor's Guide	SC28-1342	-13 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: Command Language Reference	SC28-0733	-17 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: Diagnosis Guide	GY28-1016	-07	Yes	Yes	
Resource Access Control Facility: General Information	GC28-0722	-19 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: General User's Guide	SC28-1341	-10 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: Macros and Interfaces	SC28-1345	-08 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: Messages and Codes	SC38-1014	-18 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: Migration and Planning	GC23-3054	-05 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: Security Administrator's Guide	SC28-1340	-13 <b>NEW</b>	Yes	Yes	
Resource Access Control Facility: System Programmer's Guide	SC28-1343	-12 <b>NEW</b>	Yes	Yes	
External Security Interface (RACROUTE) Macro Reference for MVS and VM	GC28-1366	-08	Yes	Yes	

## 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 an LPAR. For guest considerations, see Appendix B, “IBM Operating Systems Supported as Guests of z/VM”, on page 87.

The following terms are used in the Mode and Support columns of the server support matrix:

Term	Meaning
<b>PR/SM</b>	Processor Resource/Systems Manager. A hardware feature that supports LPAR mode and MPG capability.
<b>LPAR</b>	Logically Partitioned. On a server with PR/SM operating in LPAR mode, server resources are divided across up to thirty logical partitions, depending on the server model.
<b>IFL</b>	IBM S/390 Integrated Facility for Linux. A hardware feature that provides additional processing capacity for Linux workloads in a logical partition.
<b>MPG</b>	Multiple Preferred Guests. 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>VM Data Spaces</b>	A facility of z/VM that allows an XC virtual machine to access as many as 1022 data spaces of 2GB (gigabytes) each.
<b>ESA/390</b>	ESA/390 architecture
<b>VM310</b>	z/VM 3.1.0
<b>VM420</b>	z/VM 4.2.0
<b>VM430</b>	z/VM 4.3.0
<b>VM440</b>	z/VM 4.4.0

The following general notes apply to the matrix:

- z/VM can exploit the ESCON Multiple Image Facility (EMIF) when running in a logical partition.
- The inclusion of a server in this matrix does not imply the server is available in all countries.

Table 6. z/VM Server Support Matrix

Server	Mode	Current z/VM Support
<b>P/390, R390</b>	Basic	VM310
<b>Note on P/390, R390:</b>		
For specific service levels required, contact your IBM representative.		
<b>@server xSeries® 430 Enabled for S/390 (x/EFS)</b>	Basic	VM310

## Server Support

Table 6. z/VM Server Support Matrix (continued)

Server	Mode	Current z/VM Support
<b>Note on x/EFS:</b>		
For specific service levels required, contact your IBM representative.		
<b>S/390 Multiprise 2000</b>	Basic	VM310
	LPAR	VM310
<b>Note on Multiprise 2000:</b>		
For specific service levels required, contact your IBM representative.		
<b>S/390 Multiprise 3000 Enterprise Server</b>	Basic	VM310, VM420, VM430, VM440 (2)
	LPAR	VM310, VM420, VM430, VM440 (2)
	LPAR IFL	VM420 (1), VM430 (1), VM440 (1,2)
<b>Notes on Multiprise 3000:</b>		
For specific service levels required, contact your IBM representative.		
(1) Only Linux for zSeries, Linux for S/390, z/VM 4.2.0 or later, CMS Level 18 or later, and stand-alone utilities supplied with z/VM 4.2.0 or later run in LPAR IFL mode. 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	VM310
	LPAR	VM310
<b>Note on R2/R3:</b>		
For specific service levels required, contact your IBM representative.		
<b>9672 Parallel Enterprise Server Generation 3 (G3)</b>	Basic	VM310 (1)
	LPAR	VM310 (1)
<b>Notes on G3:</b>		
For specific service levels required, contact your IBM representative.		
(1) The CMOS Cryptographic Processor is supported for use by guests.		
<b>9672 Parallel Enterprise Server Generation 4 (G4)</b>	Basic	VM310 (1,2)
	LPAR	VM310 (1,2)
<b>Notes on G4:</b>		
For specific service levels required, contact your IBM representative.		
(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	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR IFL	VM420 (3,4), VM430 (3,4), VM440 (3,4,5)

Table 6. z/VM Server Support Matrix (continued)

Server	Mode	Current z/VM Support
<b>Notes on G5:</b>		
For specific service levels required, contact your IBM representative.		
(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 Linux for zSeries, Linux for S/390, z/VM 4.2.0 or later, CMS Level 18 or later, and stand-alone utilities supplied with z/VM 4.2.0 or later run in LPAR IFL mode. For ICKDSF support information, see the ICKDSF Program Directory.		
(4) The PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux guests. On VM420, APAR VM62905 is required. 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	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR IFL	VM420 (3,4), VM430 (3,4), VM440 (3,4,5)
<b>Notes on G6:</b>		
For specific service levels required, contact your IBM representative.		
(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 Linux for zSeries, Linux for S/390, z/VM 4.2.0 or later, CMS Level 18 or later, and stand-alone utilities supplied with z/VM 4.2.0 or later run in LPAR IFL mode. For ICKDSF support information, see the ICKDSF Program Directory.		
(4) The PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux guests. On VM420, APAR VM62905 is required. 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>@server zSeries 800 (z800)</b>	Basic	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR IFL	VM420 (3,4), VM430 (3,4), VM440 (3,4,5)
<b>@server zSeries 900 (z900)</b>	Basic	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR	VM310 (1,2), VM420 (1,2,4), VM430 (1,2,4), VM440 (1,2,4,5)
	LPAR IFL	VM420 (3,4), VM430 (3,4), VM440 (3,4,5)
<b>@server zSeries 990 (z990)</b>	LPAR	VM310 (1,2,6), VM420 (1,2,4,6), VM430 (1,2,4,6), VM440 (1,2,4,6)
	LPAR IFL	VM420 (3,4,6), VM430 (3,4,6), VM440 (3,4,6)

## Server Support

Table 6. z/VM Server Support Matrix (continued)

Server	Mode	Current z/VM Support
<p><b>Notes on zSeries:</b></p> <p>For specific service levels required, contact your IBM representative.</p> <p>(1) 370-mode operating systems will not run as guests of z/VM on this server.</p> <p>(2) The CMOS Cryptographic Processor is supported for use by guests.</p> <p>(3) Only Linux for zSeries, Linux for S/390, z/VM 4.2.0 or later, CMS Level 18 or later, and stand-alone utilities supplied with z/VM 4.2.0 or later run in LPAR IFL mode. For ICKDSF support information, see the ICKDSF Program Directory.</p> <p>(4) The PCI Cryptographic Accelerator and PCI Cryptographic Coprocessor are supported for use by Linux guests. On VM420, APAR VM62905 is required. APAR VM62933 is required for DirMaint support.</p> <p>(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.</p> <p>(6) On VM310, VM420, or VM430, z/VM compatibility support for the z990 does not provide exploitation of the following z990 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>VM440 will exploit these z990 features when applicable hardware is available.</p> <p>The compatibility support provided for dynamic-I/O configuration is designed to function with a z990 where only LCSS 0 is defined.</p> <p>Refer to the z/VM subset of the 2084DEVICE Preventative Service Planning (PSP) bucket prior to installing the z990 server.</p>		



## 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, an operating system, version, or release 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 83.

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. When z/VM 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.

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 also 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

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

Table 7. z/VM Guest Support Matrix

Guest	Host	Support
Linux for S/390	z/VM 3.1.0	VR UM ESA (1)
	z/VM 4.2.0	VR UM ESA (2)
	z/VM 4.3.0	VR UM ESA (2)
	z/VM 4.4.0	VR UM ESA (2)

## Guest Support

Table 7. z/VM Guest Support Matrix (continued)

Guest	Host	Support
<b>Notes for Linux for 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.	
(2)	The z/VM host must be running on one of the following: IBM S/390 Multiprise 3000 Enterprise Server, IBM Parallel Enterprise Server G5 or G6, or IBM zSeries.	
<b>Linux for zSeries</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM ESA (1) VR UM ESA (1) VR UM ESA (1) VR UM ESA (1)
<b>Notes for Linux for 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>OS/390 V2R10 (1)</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM ESA (2,3) VR UM ESA (2,4) VR UM ESA (2,4) VR UM ESA (2,4)
<b>Notes for OS/390 Guests:</b>		
(1)	Exploitation of hardware function by OS/390 may require specific levels of z/VM. For details, see <i>OS/390: Planning for Installation</i> , GC28-1726.	
(2)	z/VM does not support external coupling facilities or real coupling links.	
(3)	z/VM supports guest-coupling simulation on IBM S/390 Multiprise 2000, IBM S/390 Multiprise 3000 Enterprise Server, IBM S/390 Parallel Enterprise Server G3 or later, and IBM zSeries. An entire sysplex environment can be defined on a single z/VM image. z/VM guest coupling simulation is intended for test and development environments only, not for production.	
(4)	z/VM supports guest-coupling simulation on IBM S/390 Multiprise 3000 Enterprise Server, IBM S/390 Parallel Enterprise Server G5 or G6, and IBM zSeries. An entire sysplex environment can be defined on a single z/VM image. z/VM guest coupling simulation is intended for test and development environments only, not for production.	
<b>z/OS V1 (1)</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM ESA (2,3,4) VR UM ESA (2,3,4) VR UM ESA (2,3,4) VR UM ESA (2,3,4)
<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: Planning for Installation</i> , GA22-7504.	
(2)	The z/VM 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: <ul style="list-style-type: none"> <li>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.</li> <li>On an IBM zSeries, the z/OS guest must run in 64-bit mode on a 64-bit CP image.</li> </ul>	
(3)	z/VM does not support external coupling facilities or real coupling links.	
(4)	z/VM supports guest-coupling simulation. An entire sysplex environment can be defined on a single z/VM image. z/VM guest coupling simulation is intended for test and development environments only, not for production.	

Table 7. z/VM Guest Support Matrix (continued)

Guest	Host	Support
<b>TPF V4R1 (1)</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM XA ESA VR UM XA ESA VR UM XA ESA VR 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™ V2R4 - V2R6</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM XA ESA VR UM XA ESA VR UM XA ESA VR UM XA ESA
<b>z/VM 3.1.0</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3)
<b>z/VM 4.2.0</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3)
<b>z/VM 4.3.0</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3)
<b>z/VM 4.4.0</b>	z/VM 3.1.0 z/VM 4.2.0 z/VM 4.3.0 z/VM 4.4.0	VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3) VR UM ESA (1,2,3)
<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 on a 64-bit CP image on an IBM zSeries.		

## Guest Support

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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*.

z/VM does not support 7-track tapes.

The following terms are used in the device support matrix:

Term	Meaning
VM310	z/VM 3.1.0
VM420	z/VM 4.2.0
VM430	z/VM 4.3.0
VM440	z/VM 4.4.0

## Direct Access Storage Devices (DASD)

Table 8. Device Support List—DASD

Device	z/VM Releases Providing Support	Support Notes
3370 Model A01, B01, A02, B02	VM310, VM420, VM430, VM440	Not supported for z/VM installation.
3375 Model A1, B1, D1	VM310, VM420, VM430, VM440	Not supported for z/VM installation.
3380 Model A04, AA4, B04, AD4, BD4, AE4, BE4, AJ4, BJ4, AK4, BK4	VM310, VM420, VM430, VM440	Not supported for installation of VM430 or later.
3380 Model CJ2	VM310, VM420, VM430, VM440	Not supported for installation of VM430 or later.
3390 Model A14, A18, B14, B18, B1C, A24, A28, B24, B28, B2C	VM310, VM420, VM430, VM440	Supported in 3390 mode (native mode) with VSE/VSAM 2.1.0 or later.  Mixed 3390 models are not supported for installation of VM430 or later.
3390 Model A34, A38, B34, B38, B3C	VM310, VM420, VM430, VM440	Supported in 3390 mode (native mode) with VSE/VSAM 2.1.0 or later.  Mixed 3390 models are not supported for installation of VM430 or later.
3390 Model A94, A98, B94, B98, B9C	VM310, VM420, VM430, VM440	Not supported for z/VM installation.  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	VM310, VM420, VM430, VM440	Must be dedicated to a guest as a 3088.  Not supported for z/VM installation.

Table 8. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
3995 Model 151, 111 Optical Library Dataserver	VM310, VM420, VM430, VM440	<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	VM310, VM420, VM430, VM440	<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	VM310, VM420, VM430, VM440	Not supported for z/VM installation.
9335 Model B01	VM310, VM420, VM430, VM440	Not supported for installation of VM310 or later.
9336 Model 010, 020, 025	VM310, VM420, VM430, VM440	Not supported for installation of VM420 or later.
9340 Direct Access Storage Subsystem: 9345 Model B12, B22	VM310, VM420, VM430, VM440	Not supported for z/VM installation.
RAMAC <sup>®</sup> Array DASD: 9391 Model A10 Rack with 9392 Model B13 Drawers	VM310, VM420, VM430, VM440	Must be defined as a 3390. Attaches to 3990 Model 3 or Model 6 Storage Control.
RAMAC Virtual Array Subsystem: 9393 Model 002, T42, or T82	VM310, VM420, VM430, VM440	<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 VM430 or later only when emulating a 3390.</p> <p>Mixed 3390 models are not supported for installation of VM430 or later.</p>
RAMAC Array Subsystem: 9394 Model 001, 002, or 003 Cluster Array Controller with 9395 Model B13 or B23 Drawers	VM310, VM420, VM430, VM440	<p>Emulates a 3990 Model 2 Storage Control with 3390 Model 3 DASD or 3380 Model K DASD.</p> <p>Supported for installation of VM430 or later only when emulating a 3390.</p> <p>Mixed 3390 models are not supported for installation of VM430 or later.</p>
Internal Disk (for Multiprise 2000)	VM310	<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 z/VM installation.</p>

## Device Support

Table 8. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
Internal Disk (for Multiprise 3000)	VM310, VM420, VM430, VM440	<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 z/VM installation.</p> <p>Supported for installation of VM430 or later only when emulating a 3390 Model 1, 2, or 3.</p> <p>Mixed 3390 models are not supported for installation of VM430 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 8. Device Support List—DASD (continued)

Device	z/VM Releases Providing Support	Support Notes
TotalStorage Enterprise Storage Server (ESS) (2105)	VM310, VM420, VM430, VM440	<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 z/VM installation.</p> <p>Mixed 3390 models are not supported for installation of VM430 or later.</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 VM310 requires APAR VM62767 if CSE XLINK minidisks are used.</li> <li>• CMS on VM310 or VM420 requires APAR VM62936.</li> <li>• GCS on VM310 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 ESS 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 VM310, VM420, or VM430, 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

### DASD Control Units and Storage Controls

Table 9. Device Support List—DASD Control Units and Storage Controls

Device	z/VM Releases Providing Support	Support Notes
3830 Model 2	VM310, VM420, VM430, VM440	
3880 Model 1, 3, 4	VM310, VM420, VM430, VM440	
3880 Model E21, G21, H21, J21, D23, E23, G23, H23, J23	VM310, VM420, VM430, VM440	
3990 Model 1, 2	VM310, VM420, VM430, VM440	
3990 Model 3	VM310, VM420, VM430, VM440	Concurrent Copy function supported for guest use only.
3990 Model 6	VM310, VM420, VM430, VM440	All functions of former 3990 models supported plus increased cache, System Clock Support, and the Control Unit Initiated Reconfiguration feature (CUIR).  Concurrent Copy and Extended Remote Copy functions are supported for guest use only.
9221 DASD/Tape Subsystem Control	VM310, VM420, VM430, VM440	
9335 Model A01	VM310, VM420, VM430, VM440	
9340 Direct Access Storage Subsystem: 9341 Model A02 9343 Model C02, C04	VM310, VM420, VM430, VM440	
9340 Direct Access Storage Subsystem: 9343 Model D04	VM310, VM420, VM430, VM440	ESCON-attached only.
9340 Direct Access Storage Subsystem: 9343 Model CC2, CC4	VM310, VM420, VM430, VM440	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.
9340 Direct Access Storage Subsystem: 9343 Model DC4	VM310, VM420, VM430, VM440	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 10. Device Support List—Tape Units and Tape Libraries

Device	z/VM Releases Providing Support	Support Notes
2440	VM310, VM420, VM430, VM440	Must be defined as a 3420 Model 4.  Not supported for z/VM installation.
3420 Model 3, 4, 5, 6, 7, 8	VM310, VM420, VM430, VM440	Not supported for z/VM installation.
3422 Tape Unit and Control	VM310, VM420, VM430, VM440	Not supported for z/VM installation.
3424 Tape Subsystem	VM310, VM420, VM430, VM440	For Brazil only.  Not supported for z/VM installation.

Table 10. Device Support List—Tape Units and Tape Libraries (continued)

Device	z/VM Releases Providing Support	Support Notes
3430	VM310, VM420, VM430, VM440	Not supported for z/VM installation.
3480 Tape Subsystem	VM310, VM420, VM430, VM440	Non-XF not supported for installation of VM430 or later.
3490 Tape Subsystem	VM310, VM420, VM430, VM440	
3490E (Enhanced Capability Model) Tape Subsystem	VM310, VM420, VM430, VM440	
TotalStorage Enterprise Automated Tape Library (3494)	VM310, VM420, VM430, VM440	Native support is provided in conjunction with DFSMS/VM. Not supported for z/VM installation.
TotalStorage Virtual Tape Server (3494 VTS)	VM310, VM420, VM430, VM440	Native support is provided in conjunction with DFSMS/VM. Not supported for z/VM installation. VM310 and later support Peer-to-Peer VTS and VTS Import/Export feature for guests.
3495 Tape Library Dataserver	VM310, VM420, VM430, VM440	Native support is provided in conjunction with DFSMS/VM. Not supported for z/VM installation.
TotalStorage Enterprise Tape System (3590)	VM310, VM420, VM430, VM440	Not supported for VM310 or VM420 installation.  To support the 3590 Model H: <ul style="list-style-type: none"> <li>• CP on VM310, VM420, or VM430 requires APAR VM63074.</li> <li>• CMS on VM310 or VM420 requires APAR VM63073.</li> <li>• DFSMS/VM FL221 requires APAR VM63097.</li> </ul>
9348 Model 11, 12	VM310, VM420, VM430, VM440	Not supported for z/VM installation.

## Tape Control Units

Table 11. Device Support List—Tape Control Units

Device	z/VM Releases Providing Support	Support Notes
TotalStorage Enterprise Tape Controller 3590 Model A60	VM310, VM420, VM430, VM440	To support native FICON attachment of the A60, VM310 requires APAR VM62710.
3803 Model 1, 2	VM310, VM420, VM430, VM440	

## Printers

Table 12. Device Support List—Printers

Device	z/VM Releases Providing Support	Support Notes
3203 Model 5	VM310, VM420, VM430, VM440	

## Device Support

Table 12. Device Support List—Printers (continued)

Device	z/VM Releases Providing Support	Support Notes
3262	VM310, VM420, VM430, VM440	
3268 Model 2, 2C	VM310, VM420, VM430, VM440	Must be defined as a 3287.
3287 Model 1, 1C, 2, 2C, 4	VM310, VM420, VM430, VM440	
3289 Model 1, 3, 4, 8	VM310, VM420, VM430, VM440	
3800 Model 1	VM310, VM420, VM430, VM440	
3800 Model 3, 6, 8	VM310, VM420, VM430, VM440	Full support in Model 1 compatibility mode or using Advanced Function Printing™ (AFP™) licensed programs.
3812	VM310, VM420, VM430, VM440	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	VM310, VM420, VM430, VM440	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	VM310, VM420, VM430, VM440	Full support through VM/VTAM, using AFP licensed programs.
3825	VM310, VM420, VM430, VM440	Full support using AFP licensed programs.
3827	VM310, VM420, VM430, VM440	Full support using AFP licensed programs.
3835	VM310, VM420, VM430, VM440	Full support using AFP licensed programs.
3900	VM310, VM420, VM430, VM440	Must be defined as a 3800.
4245 Model 1	VM310, VM420, VM430, VM440	Supported as a 4245 or in 3262 compatibility mode.
4245 Model 12, 20	VM310, VM420, VM430, VM440	
4248 Model 1, 2	VM310, VM420, VM430, VM440	Supported as a 4248 or in 3211 compatibility mode.
6262 Model 14, 22	VM310, VM420, VM430, VM440	Must be defined as a 4248 Model 1.

## Card Readers and Card Punches

Table 13. Device Support List—Card Readers and Card Punches

Device	z/VM Releases Providing Support	Support Notes
3505 Model B1, B2	VM310, VM420, VM430, VM440	
3525 Model P1, P2, P3	VM310, VM420, VM430, VM440	

## 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.

VM440 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 14. Device Support List—Display Control Units

Device	z/VM Releases Providing Support	Support Notes
3174	VM310, VM420, VM430, VM440	
3272 Model 2	VM310, VM420, VM430, VM440	
3274	VM310, VM420, VM430, VM440	
3276 Display/Control Unit	VM310, VM420, VM430, VM440	Must be dedicated to a virtual machine as a supported device.

## Communications Controllers

Table 15. Device Support List—Communications Controllers

Device	z/VM Releases Providing Support	Support Notes
3705	VM310, VM420, VM430, VM440	Must be dedicated to a virtual machine as a supported device.
3720	VM310, VM420, VM430, VM440	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	VM310, VM420, VM430, VM440	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	VM310, VM420, VM430, VM440	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	VM310, VM420, VM430, VM440	

## Device Support

### Switches

Table 16. Device Support List—Switches

Device	z/VM Releases Providing Support	Support Notes
2032 FICON Director Model 1	VM420, VM430, VM440	
9032 ESCON Director Model 2	VM310, VM420, VM430, VM440	
9032 ESCON Director Model 3	VM310, VM420, VM430, VM440	
9032 ESCON Director Model 5	VM310, VM420, VM430, VM440	
9033 ESCON Director Model 1	VM310, VM420, VM430, VM440	
9033 ESCON Director Model 4	VM310, VM420, VM430, VM440	

**Note:** 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.

For more information about ESCON architecture, see *Introducing Enterprise Systems Connection*, GA23-0383.

### Miscellaneous Devices

Table 17. Device Support List—Miscellaneous Devices

Device	z/VM Releases Providing Support	Support Notes
Channel-to-Channel Adapter (CTCA)	VM310, VM420, VM430, VM440	Must be dedicated to a virtual machine as a supported device.
ESCON CTCA	VM310, VM420, VM430, VM440	Extended mode operation only.
FICON CTCA	VM310, VM420, VM430, VM440	Must be dedicated to a guest as a supported device.  VM310 or VM420 requires APAR VM62906.
HiperSockets	VM420, VM430, VM440	Must be dedicated to a virtual machine as a supported device.  VM420 requires APAR VM62938.  TCP/IP Level 420 requires APAR PQ51738.
OSA-2	VM310, VM420, VM430, VM440	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 17. Device Support List—Miscellaneous Devices (continued)

Device	z/VM Releases Providing Support	Support Notes
OSA-Express	VM310, VM420, VM430, VM440	<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 OSA-Express Fast Ethernet and OSA-Express 155 ATM modes.</p> <p>OSA-Express is recognized as TYPE=OSD for the OSA-Express Gigabit Ethernet mode.</p>
PCI Cryptographic Accelerator	VM420, VM430, VM440	<p>Must be dedicated to a Linux guest as a supported device.</p> <p>VM420 requires APAR VM62905.</p> <p>DirMaint Function Level 410 requires APAR VM62933.</p>
PCI Cryptographic Coprocessor	VM420, VM430, VM440	<p>Must be dedicated to a Linux guest as a supported device.</p> <p>VM420 requires APAR VM62905.</p> <p>DirMaint Function Level 410 requires APAR VM62933.</p>
3088	VM310, VM420, VM430, VM440	<p>Must be dedicated to a virtual machine as a supported device.</p>
3088 Model 61 PSCA Card (common link access to workstations)	VM310, VM420, VM430, VM440	
3172 Model 1, 2, 3	VM310, VM420, VM430, VM440	<p>Must be dedicated to a virtual machine as a supported device.</p>
3174 Model 12L, 22L	VM310, VM420, VM430, VM440	
3737 Remote Channel-to-Channel Unit Model 2	VM310, VM420, VM430, VM440	<p>Must be dedicated to a virtual machine as a supported device. Must be defined as a CTCA.</p>
3890™	VM310, VM420, VM430, VM440	<p>Must be dedicated to a guest as a supported device.</p>
4753 Network Security Processor	VM310, VM420, VM430, VM440	<p>Must be dedicated to a guest as a supported device.</p>

## Device Support

Table 17. Device Support List—Miscellaneous Devices (continued)

Device	z/VM Releases Providing Support	Support Notes
7171 Device Attachment Control Unit	VM310, VM420, VM430, VM440	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	VM310, VM420, VM430, VM440	Must be dedicated to a virtual machine as a supported device. Supported by TCP/IP for z/VM.
9034 ESCON Converter Model 1	VM310, VM420, VM430, VM440	
9035 ESCON Converter Model 2	VM310, VM420, VM430, VM440	



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