z/VM™
built on IBM Virtualization Technology

IBM

General Information

Version 4 Release 3.0

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Fifth Edition (April 2002)

This edition applies to Version 4, Release 3, Modification 0 of IBM® z/VM™ (product number 5739-A03) and to all subsequent releases and modifications until otherwise indicated in new editions.

This edition replaces GC24-5991-03.

Contents

Preface

This book provides general information about the IBM z/VM Version 4 Release 3.0 (z/VM 4.3.0) licensed program:

- Introduction to z/VM
- Summary of new functions, enhancements, and other changes in this release
- Technical information, such as hardware and program requirements, packaging information, and product restrictions
- Descriptions of the z/VM base components, additional facilities, and optional features
- Guide to the product documentation
- Support for IBM servers, guest operating systems, and devices

Note: This book is available at the Announcement of z/VM 4.3.0. Some sources of additional information identified in this book may not be available until the General Availability (GA) of z/VM 4.3.0.

Who Should Read This Book

This book is intended for current users of VM products, as well as new users. It provides information to help users evaluate z/VM 4.3.0 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.

You might use the information in this book if you:
- Plan to install z/VM 4.3.0 and want to get acquainted
- Plan to migrate to z/VM 4.3.0 from a previous VM system
- Need basic knowledge about z/VM for any reason

Where to Find More Information

You can obtain more information about z/VM from the books listed in the z/VM library guide, which begins on page 55. The library guide includes an abstract for each z/VM book.

PDF Links to Other Books

The PDF version of this book provides links to other IBM books by file name. The name of the PDF file for an IBM book is unique and identifies the book and its edition. The book links provided in this book are for the editions (PDF file names) that were current when this PDF file was generated. Newer editions of some books (with different file names) may exist. A PDF link from this book to another book works only when a PDF file with the requested file name resides in the same directory as this book.

How to Send Your Comments to IBM

Your feedback is important in helping us to provide the most accurate and high-quality information. If you have comments about this book or any other VM documentation, send your comments to us using one of the following methods. Be sure to include the name of the book, the publication number (including the suffix), and the page, section title, or topic you are commenting on.

- Visit the z/VM web site at:

  http://www.ibm.com/eserver/zseries/zvm/

  There you will find the feedback page where you can enter and submit your comments.

- Send your comments by electronic mail to one of the following addresses:

  Internet: vmpub@us.ibm.com

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Chapter 1. Introducing z/VM

z/VM Version 4 is a high-performance, interactive, multiple-access operating system for IBM zSeries™ and S/390® servers. It provides a unique mix of services in support of interactive users, client/server environments, and the capability to run full-function operating systems such as z/OS™, LINUX®, and z/VM itself as "guest" systems.

Note: z/VM is the successor to IBM's VM/ESA® operating system. Many products and functions supported on z/VM may continue to use VM/ESA in their names.

z/VM consists of the following:

- Base components:
  - Control Program (CP)
  - Conversational Monitor System (CMS)
  - REXX/VM
  - Group Control System (GCS)
  - Transparent Services Access Facility (TSAF)
  - APPC/VM VTAM® Support (AVS)
  - Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E)
  - Dump Viewing Facility

  For more information, see Chapter 4, "z/VM Base Components" on page 35.
- Additional no-cost facilities:
  - Data Facility Storage Management Subsystem for VM (DFSMS/VM®)
  - Language Environment® for OS/390® & VM
  - Open Systems Adapter Support Facility (OSA/SF)
  - TCP/IP for z/VM

  For more information, see Chapter 5, "z/VM Additional Facilities" on page 47.
- Optional priced features:
  - Directory Maintenance Facility (DirMaint™)
  - Performance Reporting Facility (PRF)
  - RealTime Monitor (RTM)
  - Resource Access Control Facility for VM (RACF® for VM)

  For more information, see Chapter 6, "z/VM Optional Features" on page 51.

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 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 Message Queuing Series (MQSeries) enables applications on different systems and architectures to work together. VM support for MQSeries enables client or server applications in the network to connect to applications on VM that have implemented the MQSeries communication protocol. (Use of the MQSeries APIs on VM requires the deployment of an MQSeries 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 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:
- Transmission control protocol/internet protocol (TCP/IP)
- Systems network architecture (SNA)
- Binary synchronous communications (BSC)
- X.25
- Token-Ring
- Ethernet
- X-Windows
- Network file system (NFS)
- File transfer protocol (FTP)
- Simple mail transfer protocol (SMTP)
- X.400 mail exchange protocol
- Fiber distributed data interface (FDDI)

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 VM system images or processors.

z/VM 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 processor 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 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 z/OS and Linux for zSeries 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 VM" on page 83.

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

- **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.
- **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 processor models as long as the minimum hardware requirements are present. This enables a smaller processor model that has less real storage, fewer channels, fewer direct access devices, and fewer unit record devices than a larger processor 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 exits**. Customer-written 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 VM system and DASD. Tivoli Storage Manager moves the responsibility for storage management to 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:
- Assembler
- C
- C++
- COBOL
- FORTRAN
- Java
- Language Environment
- MQSeries Client
- 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:
- OpenExtensions Services (POSIX interfaces)
- OpenExtensions Shell and Utilities (UNIX-like interactive environment)
- 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:
- Extended Architecture (XC) support
- CMS Pipelines
- CMS multitasking services
- Callable services library (CSL)
- Program Management Binder for CMS
- Reusable Server Kernel
- CMS 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
- Backup/archive of programmable workstation or LAN server data
- Services for NetWare LAN servers
- Accessing other systems
- System management
- Network management
- System testing

z/VM Is Proven

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.
  - Integrated access control and authentication services may be augmented with the addition of external security managers.
  - Kerberos authentication and Secure Socket Layer (SSL) support are provided through TCP/IP for z/VM.
  - RACF for VM feature provides additional data security capability.

  Also see "Integrity and Security" on page 29.
- 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® 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.

Chapter 2. New Functions, Enhancements, and Other Changes

This chapter provides an overview of the major functions and enhancements provided in z/VM 4.3.0 (compared with z/VM 4.2.0). These new functions and enhancements, plus other important changes, are briefly described in the following sections:

- "Network Computing"
- "Support for New Products and Hardware Architecture" on page 8
- "Application Development and Deployment" on page 10
- "Operating System" on page 10
- "Packaging, Installation, and Service" on page 13
- "Library" on page 14

Network Computing

This section describes the new or enhanced network computing capabilities of z/VM.

TCP/IP for z/VM, Level 430

TCP/IP Level 430 contains the functions available in TCP/IP Level 420 plus the following:

- **Device support enhancements**

  The TCP/IP stack has been enhanced to support the following:
  - Multicast for HiperSockets
  - Broadcast for QDIO

- **Performance improvements**

  Key sections of TCP/IP routing, device driver, and other processes have been optimized. By primarily recoding these processes in Assembler Language, improvements in performance of high-use code paths in the z/VM TCP/IP stack have been achieved. In addition to recoding, some algorithms were changed to provide equivalent functions at lower CPU costs.

  When TCP/IP is configured to use the equal-cost multipath support, the routing table will maintain up to four equal-cost paths to a particular destination, providing load balance support and better performance.

- **NETSTAT OBEY**

  Some functions of OBEYFILE such as starting and stopping devices and performing other simple control tasks can be accomplished by using the OBEY function of the NETSTAT command.

- **New FTP subcommand**

  A new FTP PASSIVE subcommand has been added to control whether the client or the server establishes connections for data transfers.

- **TCP/IP stack vulnerability reduction**

  Function has been added to improve the performance and reliability of the TCP/IP stack by recording and reporting additional Denial-of-Service (DoS) attacks and preventing their propagation. These attacks include: Kiss-of-Death (KOD), KOX, Stream, R4P3D, Blat, and SynFlood.

The Smurf DoS attack has also been updated to address three variants of the attack—Smurf-IC, Smurf-OB, and Smurf-RP.

- **Dynamic stack configuration**

  The new IFCONFIG command allows authorized users to define, change, or display the TCP/IP configuration dynamically. Following the general syntax of the Linux/UNIX *ifconfig* command, the IFCONFIG command eliminates the need to learn the statement syntax of the z/VM TCP/IP server configuration file. Optionally, the IFCONFIG command can generate syntactically-correct configuration statements for incorporation into the configuration file to make the dynamic changes permanent.

For more information about TCP/IP enhancements, see *z/VM: TCP/IP Level 430 Planning and Customization*.

VM Guest LAN Enhancements

The VM Guest LAN implementation has been extended to support multicast transmission across HiperSockets Guest LANs. Also, Guest LANs can now be defined to function as either HiperSockets transport media or OSA-Express QDIO transport media. The addition of QDIO simulation allows the virtualization of a QDIO LAN environment and provides support for the broadcast capability that is part of the QDIO architecture. As with the z/VM HiperSockets simulation, no real hardware is required to support the OSA-Express QDIO simulation.

Serviceability aids have been added in the form of an AIF trace option to trace the occurrence of Adapter Interruption Facility events, and external symbols are defined to mark key points for adding TRSOURCE traps.

The following new CP commands have been added for this support:
- SET VMLAN
- TRACE AIF

The following CP functions have been updated:
- DEFINE LAN system configuration statement
- SPECIAL directory control statement
- COUPLE command
- DEFINE LAN command
- DEFINE NIC command
- QUERY LAN command
- QUERY NIC command
- QUERY VMLAN command
- SET LAN command

For more information, see:
- *z/VM: CP Planning and Administration*
- *z/VM: CP Command and Utility Reference*

Support for New Products and Hardware Architecture

This section describes support for new products and hardware architecture.

IBM @server zSeries 800

z/VM supports the new IBM @server zSeries 800 (z800).

Enterprise Storage Server™ (ESS) Large Volumes

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

Note: The support for ESS large volumes in Directory Maintenance Facility (DirMaint) Function Level 410 is provided by APAR VM62907. (The PTF for APAR VM62907 is available as service on the stacked RSU provided with z/VM 4.3.0.) The support in DFSMS/VM Function Level 221 is provided by APAR VM63004.

Fibre Channel Protocol (FCP) Guest Support

z/VM provides guest support for the new FCP hardware channel. This channel allows an IBM zSeries server to connect to a fibre-channel fabric. The z/VM support allows guest operating systems to access selected devices on Small Computer System Interface (SCSI) controllers connected to the fabric.

The programs operating in guest virtual machines on z/VM are responsible for providing the appropriate support to use and control the SCSI devices connected through the FCP channel. Your system administrator is responsible for ensuring the necessary level of access control and concurrent-access data integrity for the SCSI devices. z/VM itself neither uses any SCSI devices nor controls guest access to them. z/VM allows the dedication of zSeries subchannels on FCP channels to a guest. Each subchannel allows the guest to access any SCSI device for which access permission has been granted to the worldwide port name of the FCP channel within the fibre-channel infrastructure. Typical access controls within the infrastructure include zoning in the switches and Logical Unit Number-masking (LUN-masking) in the controllers.

When FCP-based SCSI support is available from Linux for zSeries, guest Linux operating systems can access data on the SCSI devices connected to the fibre-channel fabric. Access to SCSI devices by a Linux guest is governed by open standards for fibre-channel fabrics and controllers as well as by proprietary or commonly-available functions provided by individual vendors. Therefore, unlike the device isolation provided among virtual machines by z/VM and z/Architecture for devices connected to other types of channels, neither z/VM nor the FCP channels provide for the isolation of SCSI devices to a single virtual-machine configuration.

The following CP commands have been updated for this support:
- ATTACH
- DEFINE CHPID / PATH
- DETACH (Real Device)
- QUERY ALL
- QUERY CHPID / PATH
- QUERY (Real Device)
- QUERY VIRTUAL ALL

- QUERY (Virtual Device)

For more information, see the *z/VM: CP Command and Utility Reference*.

Performance Monitor Enhancement

To correctly extract processor configuration data and performance data from each of the I/O processors on zSeries servers, CP has been updated to issue new hardware instructions and record the appropriate monitor information. The Performance Reporting Facility (PRF) feature has been updated to process this new monitor data. For more information, see *z/VM: Performance Reporting Facility Function Level 410*.

Note: The support in PRF Function Level 410 is provided by APAR VM63032. The PTF for this APAR is available as service on the stacked RSU provided with z/VM 4.3.0.

Application Development and Deployment

This section describes enhancements to aid application development and deployment on z/VM.

Increased 64-bit Addressing Support for DIAGNOSE Codes

The following DIAGNOSE codes now support the 64-bit addressing mode:
- DIAGNOSE code X'08' – Virtual Console Function
- DIAGNOSE code X'44' – Voluntary Time Slice End
- DIAGNOSE code X'4C' – Generate Accounting Records
- DIAGNOSE code X'DC' – Control Application Monitor Record Collection
- DIAGNOSE code X'258' – Page-Reference Services

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

Operating System

This section describes new or enhanced z/VM operating system functions.

Automated Shutdown Support

By virtualizing a hardware interface, Automated Shutdown enables guests to shut themselves down when signaled to do so by a z/VM CP command. This support is exploited by z/VM when running as a guest and can also be exploited by other guest operating systems. The amount of elapsed time during which a guest is allowed to process a termination signal is limited by a timeout interval. Automated Shutdown can also be used to cause z/VM itself to shut down when a hardware event (for example, deactivation of the logical partition) is initiated while z/VM is active. In this situation, guest virtual machines may, at customer discretion, be given an opportunity to shut themselves down before z/VM terminates.

The following new CP functions have been added for this support:
- SET SIGNAL system configuration statement
- QUERY SHUTDOWNTIME command
- QUERY SIGNAL command
- QUERY SIGNALS command
- SET SHUTDOWNTIME command

- SET SIGNAL command
- SIGNAL command

The following CP commands have been updated:
- FORCE
- SHUTDOWN

For more information, see:
- *z/VM: CP Planning and Administration*
- *z/VM: CP Command and Utility Reference*

Enhanced Timer Management

The performance of CP timer management has been improved for environments where a large number of requests are scheduled, particularly for short intervals, and where timer requests are frequently canceled before they become due. A system with large numbers of Linux or z/OS guests with certain workloads would be an example of such an environment. Master-processor overhead has been reduced by allowing timer events to be handled on any processor. Also, clock comparator settings are now tracked and managed across all processors to eliminate duplicate or unnecessary timer interruptions.

Improved Utilization of Large Real Storage

System performance may be improved with better utilization of large real storage when Expanded Storage is unavailable, full, or nearly full while CP is replenishing its available-page list. This is accomplished by moving pages to storage above the 2GB line when:
- Pages would otherwise go to DASD
- No Expanded Storage has been made available
- Expanded Storage is not available when requested
- Excess storage is available above the 2GB line

Shared Tape Support

Shared tape support allows multiple guest operating systems to serially share the same tape device (IBM 3424, 3480, 3490, or 3590). It removes the need to manage the movement of a dedicated tape device from one guest to another, because the tape device can now remain attached to several guests concurrently. This support is specifically targeted for z/OS, z/OS.e, and OS/390 guests that use ATS Star or IEFAUTOS for automatic tape switching. In principle, however, it will work for any guest that manages its own assignment of tape devices. Traditionally, a tape device would be attached to such a guest with the CP ATTACH command using the NOASSIGN option. This support is not intended for CMS unless some external means of managing assignments or serializing access to the tape device among the sharing users is explicitly implemented.

The MULTIUSER option has been added to the CP ATTACH command and the DEDICATE directory control statement to specify that a tape device is to be shared. The QUERY ALL, QUERY (Real Device), and QUERY TAPES commands have been enhanced to return information about which tape devices are attached MULTIUSER. Assign and Unassign CCWs are simulated for tape devices attached MULTIUSER so that guests running under the same VM image can serialize access to the tape devices they share. The ALL option has been added to the CP DETACH

command to allow removal of a shared tape device from all sharing guests with one command invocation. Third party assignment and multiple system assignment (Control Access CCW) are not supported.

For more information, see:
- *z/VM: CP Planning and Administration*
- *z/VM: CP Command and Utility Reference*

Virtual Machine Accounting Improvements

CP has been enhanced with additional capability to account for the use of system resources by virtual machines, including those running Linux. A new accounting record is produced that tracks a virtual machine's use of virtual network resources, including virtual channel-to-channel adapters (CTCAs), inter-user communication vehicle (IUCV) or advanced program-to-program (APPC) connections, and virtual (Guest LAN) network interface cards (NICs).

The following CP functions have been updated:
- DEFINE LAN system configuration statement
- VMLAN system configuration statement
- OPTION directory control statement
- ACNT command
- DEFINE LAN command
- QUERY LAN command
- QUERY VMLAN command
- SET LAN command
- SET VMLAN command
- DIAGNOSE code X'4C' (Generate Accounting Records)
- Accounting records — Accounting Records for Network Data Transmissions (Record Type 0C) has been added.

For more information, see:
- *z/VM: CP Planning and Administration*
- *z/VM: CP Command and Utility Reference*
- *z/VM: CP Programming Services*

Virtual Machine Resource Manager

The new Virtual Machine Resource Manager (VMRM) provides functions in z/VM to:
- Manage guest performance

  Capabilities have been added that allow z/VM to manage guest performance to meet customer-defined goals. A new 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

  I/O management facilities have been added that enable z/VM to exploit the hardware I/O Priority Queueing facility to prioritize guest and host I/O operations. A virtual equivalent of the hardware facility is provided, allowing 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 defined by a new CP command. z/VM will automatically set a priority for I/O operations initiated by virtual machines that do not exploit this function.

The following CP functions have been added for this support:
- IOPRIORITY directory control statement
- QUERY IOPRIORITY command
- SET IOPRIORITY command

For more information, see:
- *z/VM: Performance*
- *z/VM: CP Planning and Administration*
- *z/VM: CP Command and Utility Reference*

VM Dump Tool Enhancement

The structure of the VM Dump Tool has been changed to use 31-bit addressing instead of 24-bit addressing. While this did not directly affect any external interfaces, it should reduce storage requirements in the virtual machine below the 16MB line.

Packaging, Installation, and Service

This section describes changes to the product packaging and to the installation and service procedures.

Resource Access Control Facility (RACF) Feature Added

RACF for VM is offered as an optional priced feature of z/VM. RACF works with existing z/VM system functions to provide improved data security for an installation. RACF helps meet the need for security by providing:
- Flexible control of access to protected resources
- Protection of installation-defined resources
- Ability to store information for other products
- Choice of centralized or decentralized control of profiles
- Transparency to end users
- Exits for installation-written routines

For more information, see "Resource Access Control Facility for VM (RACF for VM)" on page 52.

The RACF for VM feature is functionally equivalent to the RACF for VM V1R10.0 licensed program (5740-XXH). However, only the RACF for VM feature is licensed to run on z/VM in an Integrated Facility for Linux (IFL) LPAR.

Installation Changes

The following changes affect the installation of z/VM:
- 3590 tape drive is now supported for installation.
- Non-XF 3480 tape drive is no longer supported for installation.
- 4mm DAT drive is no longer supported for installation
- 3380 DASD is no longer supported for installation.

- Mixed DASD are no longer supported for installation. All 3390 DASD used for installation must be the same model.
- Installation of TSAF and AVS is no longer optional; they are now part of the base installation.

TCP/IP Configuration Wizard

A new utility automates the connection of a newly-installed z/VM system to a TCP/IP-based network. The TCP/IP configuration wizard requires no knowledge of TCP/IP for z/VM and is similar to the network configuration utilities used in Linux for zSeries distributions during Linux installation. This easy-to-use configuration wizard assists the z/VM installer in providing desired Internet Protocol (IP) configuration information such as host and domain name, IP addresses, and subnet mask. From that information, the wizard generates an initial z/VM TCP/IP configuration and verifies that connectivity to the network has been established. For more information, see the *z/VM: Installation Guide*.

Service Enhancements

The SERVICE tool can now detect local modifications and present that information to you. This allows you to rework your local modifications before the new service is built into executables. The new VMFUPDAT command provides a panel interface that displays which local modifications need to be reworked and allows updates to the System-Level Service Update Facility table. For more information, see the *z/VM: VMSES/E Introduction and Reference*.

Library

This section describes major changes to the z/VM product library.

Books Added to the Library

The following books have been added to the z/VM library to support the new RACF for VM feature:
- *RACF: Auditor's Guide*, SC28-1342
- *RACF: Command Language Reference*, SC28-0733
- *RACF: Command Language Reference Summary*, SX22-0014
- *RACF: Diagnosis Guide*, GY28-1016
- *RACF: General Information*, GC28-0722
- *RACF: General User's Guide*, SC28-1341
- *RACF: Macros and Interfaces*,
- *RACF: Messages and Codes*,
- *RACF: Migration and Planning*,
- *RACF: Security Administrator's Guide*, SC28-1340
- *RACF: System Programmer's Guide*, SC28-1343

For information about the edition levels and available formats for these books, see "Editions and Formats of z/VM Books" on page 71.

Updated Books

The DFSMS/VM books have been revised and updated. The *DFSMS/VM Diagnosis Guide* is now an unlicensed book and is included on the *Online Library Omnibus Edition: VM Collection* CD-ROM.

For a list of all the books that have been updated with new editions for z/VM 4.3.0, see "Editions and Formats of z/VM Books" on page 71.

Divided Books

The following table lists z/VM books that have been divided into multiple books.

Table 1. Divided Books

Old Title and Number	New Titles and Numbers
z/VM: Planning and Administration, SC24-5995	• *z/VM: CMS Planning and Administration*, SC24-6042 • *z/VM: CP Planning and Administration*, SC24-6043 • *z/VM: Dynamic I/O Configuration Planning and Administration*, SC24-6044 • *z/VM: Saved Segments Planning and Administration*, SC24-6056

Relocated Information

The following table shows information that has been relocated within the z/VM library.

Table 2. Relocated Information

Topics	Old Location (Book)	New Location (Book)
• Setting up OpenExtensions • DIRPOSIX utility	*z/VM: Planning and Administration*	*z/VM: OpenExtensions User's Guide*
• DFSMS/VM installation	*VM/ESA: DFSMS/VM Function Level 221 Installation and Customization* **Note:** This book has been renamed to *z/VM: DFSMS/VM Function Level 221 Customization.*	*DFSMS/VM Function Level 221 Program Directory*
• DirMaint control files	*Directory Maintenance VM/ESA: Diagnosis Reference* (not updated for DirMaint Function Level 410)	*z/VM: Directory Maintenance Facility Function Level 410 Tailoring and Administration Guide*
• Tailorable and nontailorable DirMaint system files	*DirMaint Program Directory*	*z/VM: Directory Maintenance Facility Function Level 410 Tailoring and Administration Guide*

Chapter 3. Technical Information

This chapter identifies the hardware and software (program) requirements of the z/VM 4.3.0 base components, additional facilites, and optional features. It also includes packaging and ordering information and discusses product restrictions and security. It contains the following sections:

- "Hardware Requirements"
- "Supported Server Modes" on page 19
- "Device Support" on page 20
- "Program Requirements" on page 21
- "Operating Systems Supported as Guests" on page 26
- "Other Programs Supported on z/VM" on page 26
- "National Language Support (NLS)" on page 26
- "Packaging and Ordering Information" on page 27
- "Object Code Only and Limited Source Availability" on page 28
- "Restrictions" on page 28
- "Integrity and Security" on page 29

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/

Hardware Requirements

This section lists the hardware required by the z/VM base and by the z/VM additional facilities and optional features. It covers the following topics:

- "Hardware Requirements for the z/VM Base"
- "OSA and OSA/SF Hardware Requirements" on page 19
- "TCP/IP for z/VM Hardware Requirements" on page 19

Hardware Requirements for the z/VM Base

The z/VM base has minimum hardware and storage requirements. The Cross-System Extensions function has additional hardware requirements.

Minimum Hardware Configuration
The minimum hardware configuration supported is:

- A server capable of running z/Architecture or ESA/390 architecture

  For information about the IBM servers supported by z/VM, see Appendix A, "IBM Processors Supported by VM" on page 79.

  The server must have:
  – At least 8MB of real storage
  – One processor unit
  – One processor controller or support processor
  – One channel subsystem

  Specific server facilities are also required. For more information, see the following Web site:

http://www.ibm.com/eserver/zseries/zvm/zvm430/architecture/

- One system console (to control the server)
- One operator console (to control the operating system); this must be a local non-SNA 3270 terminal or equivalent
- Direct access storage devices:
  - Seven 3390 single-density or
  - Four 3390 double-density or
  - Three 3390 triple-density

  Notes:

  1. The 3390 Model 9 is not supported for installation.
  2. All 3390 DASD used for installation must be the same model.
  3. If you choose not to install some optional items, your DASD requirements may be less than indicated above. For more information, see the *z/VM: Installation Guide*.

- One of the following input devices:
  - 3480 tape subsystem (XF only)
  - 3490 tape subsystem
  - 3490E tape subsystem
  - 3590 tape subsystem
  - CD-ROM (emulating a 3422 tape drive)

IBM recommends that you also include a printer in your hardware configuration, so that you can obtain important diagnostic information if you encounter a problem during IPL.

Installation from CD-ROM
Installation from CD-ROM requires one of the following:

- IBM S/390 Multiprise® 3000 Enterprise Server
- IBM 2074 Console Support Controller (GA1 requires EC level J10980)
- Optical Media Attach/2 Program (5621-264)

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 CSL libraries have also been saved as a saved segment).

Cross-System Extensions 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. The cross system link function of CSE is not supported for FBA devices.

OSA and OSA/SF Hardware Requirements

A full list of OSA and OSA/SF hardware requirements is too detailed for the scope of this book. For that information, especially for the servers that the OSA supports, refer to one or more of the following:

- IBM sales manual
- *S/390: Planning for the S/390 Open Systems Adapter (OSA-1, OSA-2) Feature*
- *zSeries 900: Planning for the Open Systems Adapter-2 Feature*

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. See the *VM/ESA: Open Systems Adapter Support Facility User's Guide for OSA-2*.

TCP/IP for z/VM Hardware Requirements

TCP/IP Level 430 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) Token Ring, FDDI, Fast Ethernet, and 155 ATM
- IBM Open Systems Adapter Express (OSA-Express) Gigabit Ethernet, Fast Ethernet, 155 ATM, and Token Ring
- 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® Channel Attachment using the Block Multiplexer Channel or ESCON® Adapter
- IBM 3088 Multi-system Channel Communication Unit

  TCP/IP for z/VM supports direct connection to another TCP/IP for VM, Linux for S/390, 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 VM, Linux for S/390, z/OS, or OS/390 using the IBM ESCON Channel-to-Channel Adapter.

TCP/IP Level 430 also requires a 3270-equivalent workstation for TCP/IP administration.

Supported Server Modes

z/VM supports basic mode on all supported zSeries and S/390 servers. See Appendix A, "IBM Processors Supported by VM" on page 79.

If the Processor Resource/Systems Manager™ (PR/SM™) feature is installed on the server, z/VM also supports logically partitioned (LPAR) mode. For information on how z/VM operates on servers with the PR/SM feature, see "Processor Resource/Systems Manager (PR/SM)" on page 40.

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 VM" on page 87. 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 VM" on page 87, 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 VM" on page 87, 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.

Program Requirements

This section lists the licensed programs and other program materials required by the z/VM base and by the z/VM additional facilities and optional features. It covers the following topics:

- "Program Requirements for the z/VM Base"
- "DFSMS/VM Program Requirements" on page 23
- "Language Environment for OS/390 & VM Program Requirements" on page 23
- "OSA/SF Program Requirements" on page 23
- "TCP/IP for z/VM Program Requirements" on page 24
- "Directory Maintenance Facility Program Requirements" on page 24
- "Performance Reporting Facility Program Requirements" on page 25
- "RealTime Monitor Program Requirements" on page 25
- "RACF for VM Program Requirements" on page 25
- "Program Requirements for VM Related Products" on page 25
- "Online Books Program Requirements" on page 25

Program Requirements for the z/VM Base

z/VM has prerequisite IBM licensed programs and may have additional program requirements to perform certain functions.

Prerequisite Licensed Programs

z/VM requires the following IBM licensed programs:

- Environmental Record Editing and Printing (EREP/VM) Version 3 (5654-260) Release 5.0
- Device Support Facilities: ICKDSF for VM (5684-042) Release 16 or later

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.

Current Levels of z/VM Facilities and Features

The following list shows the current levels of z/VM additional facilities and optional features. Additional APARs may be required. See the program requirements for the specific facility or feature later in this chapter.

- DFSMS/VM Function Level 221
- Language Environment 1.8
- OSA/SF 2.2.0
- TCP/IP Level 430
- Directory Maintenance Facility Function Level 410
- Performance Reporting Facility Function Level 410
- RealTime Monitor Function Level 410
- RACF for VM (V1R10.0)

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:

- 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, FS2SFSER, 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 all of the above plus:
  - Running applications that exploit the IEEE Floating Point hardware facility
- Release 4.0 or later is required for all of the above plus:
  - 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
  - Installing and servicing RealTime Monitor
  - Applying updates to CP replacement parts from service for the RACF for VM feature

Cross-System Extensions 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 4.3.0 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 Directory Maintenance Facility Function Level 410 program code.

- For shared spool and cross-system messaging:
  - VM/Pass-Through Facility Version 2 (5684-100) Release 1.1 or later

OpenExtensions Program Requirements

To do OpenExtensions application development in C, you need the C compiler included in the following licensed program:

- IBM C for VM/ESA Version 3 (5654-033) Release 1.0

DFSMS/VM Program Requirements

DFSMS/VM requires the following licensed programs:

- 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 VM feature, 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
- 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 Level 430
- 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 Enterprise Storage Server.

Language Environment for OS/390 & VM Program Requirements

To customize Language Environment 1.8, 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

OSA/SF Program Requirements

OSA/SF can be accessed by a CMS user ID, by a REXX call to the OSA/SF API, and at the OSA/SF graphical user interface (GUI).

Access at the OSA/SF GUI requires one of the following:

- Microsoft Windows 95 4.00.950B (OSR2)
- Microsoft Windows NT® 4.0 with Service Pack 3
- IBM OS/2 Warp Version 4.0 fixpack 6

Access at the OSA/SF GUI also requires one of the following communications protocols:

- For TCP/IP communications:
  - TCP/IP Level 430 on the host
  - TCP/IP on the workstation
- For Advanced Peer to Peer Communication (APPC):
  - ACF/VTAM® Version 4 Release 2 or later on the host
  - Personal Communications/3270 Version 4 (5871-AAA) Release 2 with APAR IC22680 or later on the workstation (Version 4 Release 3 is recommended)
- For EHLLAPI (3270):
  - 3270-PC File Transfer Program on the host
  - Personal Communications/3270 Version 4 (5871-AAA) Release 2 or later on the workstation (Version 4 Release 3 is recommended)

To support an OSA in its TCP/IP Passthru mode in a z/VM environment, OSA/SF requires TCP/IP Level 430. OSA/SF is required in TCP/IP Passthru mode when sharing OSA ports among logical partitions or for defining the emulated/logical ports of a 155 ATM feature.

TCP/IP for z/VM Program Requirements

TCP/IP Level 430 requires z/VM 4.3.0 and Language Environment 1.8. Previous levels of CP, CMS, and Language Environment cannot be used.

TCP/IP Level 430 has the following additional program requirements:

- 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 VM feature, or an equivalent product
- If programs are developed in C:
  - IBM C for VM/ESA Version 3 (5654-033) Release 1
- If programs are developed in Pascal:
  - IBM VS Pascal Version 1 (5668-767) Release 2 Compiler and Library

For more information about program requirements for TCP/IP Level 430, see *z/VM: TCP/IP Level 430 Planning and Customization*.

Directory Maintenance Facility Program Requirements

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.

The PTFs for these APARs are available as service on the stacked RSU provided with z/VM 4.3.0.

Performance Reporting Facility Program Requirements

Performance Reporting Facility Function Level 410 requires PRF APAR VM63032 to support the new monitor records 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 4.3.0.

RealTime Monitor Program Requirements

To install and service RealTime Monitor Function Level 410, you need the following licensed program:

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

RealTime Monitor Function Level 410 requires RTM APAR GC05481 to support the updated CP control blocks in z/VM 4.3.0. The PTF for this APAR is available as service on the stacked RSU provided with z/VM 4.3.0.

RACF for VM Program Requirements

To apply updates to CP replacement parts from service for the RACF for VM feature, you need the following licensed program:

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

Program Requirements for VM Related Products

The following VM-related products require the specified APARs to run on z/VM 4.3.0:

- 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.)

Online Books Program Requirements

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

PDF Books

To open and view PDF books on your workstation, the Adobe 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 (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
- C/370™ Library Version 2 (5688-188) Release 2 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 Online Library Omnibus Edition: VM Collection* CD-ROM supplied with z/VM.

Operating Systems Supported as Guests

For information about the specific levels of IBM operating systems supported as guests on z/VM, see Appendix B, "IBM Operating Systems Supported as Guests of VM" on page 83.

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 (NLS)

z/VM provides National Language Support (NLS) for several of its components, facilities, and features. End users can selectively (through commands) receive messages and HELP in their national language. Any of the supported languages 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, user A can be using German while user B is using Japanese.

z/VM Base

z/VM provides the following IBM-translated components:

Language	Translated Components
German	CP, CMS, and REXX/VM
Japanese	CP, CMS, and REXX/VM

Note: Some parts of these components may not be translated.

CP lets virtual machines write Double-Byte Character Set (DBCS) display data to display devices (in line mode) while CP manages the display screen.

z/VM provides these translated components plus mixed-case American English (AMENG) and uppercase American English (UCENG) on the z/VM system DDR.

DFSMS/VM

DFSMS/VM panels and messages are available in Japanese (KANJI) as well as mixed-case American English (AMENG) and uppercase American English (UCENG).

In addition to supporting these languages, DFSMS/VM also supports multiple active languages at the same time. For example, a user could have their virtual machine set to uppercase English, enter a DFSMS MIGRATE command, and the reader file returned to the user would be in uppercase English. Also, another user could have their virtual machine set to Japanese, enter the same command at the same time the other user issued the command, and the reader file returned to this user would be in Japanese.

DirMaint

DirMaint messages are available in Japanese (KANJI) as well as mixed-case American English (AMENG) and uppercase American English (UCENG).

Packaging and Ordering Information

To order z/VM 4.3.0 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 4.3.0 System DDR
- z/VM SDO Optional Products Enabling Aid
- z/VM SDO licensed products

For more information about the z/VM SDO, refer to the following Web site:

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 88). The system DDR image is available on 3480, 3490, or 3590 tape cartridges or CD-ROM disks.

The system DDR contains:
- CP
- CMS
- REXX/VM
- VMSES/E
- GCS (preinstalled on minidisks)
- AVS (preinstalled on minidisks)
- TSAF (preinstalled on minidisks)
- Dump Viewing Facility
- 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
- Language Environment 1.8
- OSA/SF 2.2.0
- TCP/IP Level 430 (includes source)
- Directory Maintenance Facility Function Level 410
- Performance Reporting Facility Function Level 410
- RealTime Monitor Function Level 410
- RACF for VM (V1R10.0)
- EREP/VM Version 3 (5654-260) Release 5
- ICKDSF for VM (5684-042) Release 16 (includes ICKDSF Standalone Release 16)
- RSCS Version 3 (5684-096) Release 2.0

- Tivoli Storage Manager for VM Version 4 (5698-TSM) Release 1.0

Notes:

1. The Directory Maintenance Facility, Performance Reporting Facility, RealTime Monitor, and RACF for 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 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 Function Level 221
- 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.

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

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

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).

Directory Maintenance Facility 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 $DIR*xxx*$ 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.

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.

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.

Directory Maintenance Facility 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 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 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 Socket 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 an ESM, such as RACF for VM, to:
  - Authenticate and authorize access to resources managed by the server
  - Validate client user IDs and passwords

Directory Maintenance Facility Security

DirMaint supports the z/VM security strategy:

- Access to user IDs is password controlled. DirMaint maintains user passwords, with customer choice of administration control or user control. DirMaint also supports the use of an ESM for password control.

- Access to minidisks is controlled by either passwords or explicit link authorization, as determined by the minidisk owner. Minidisk passwords are optional for controlling minidisk directory links. DirMaint also supports control of minidisk links by an ESM.

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

The RACF for VM feature 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.

Chapter 4. z/VM Base Components

This chapter describes the base components of z/VM:

- "Control Program (CP)"
- "Conversational Monitor System (CMS)" on page 41
- "REXX/VM" on page 45
- "Group Control System (GCS)" on page 45
- "Transparent Services Access Facility (TSAF)" on page 45
- "APPC/VM VTAM Support (AVS)" on page 45
- "Virtual Machine Serviceability Enhancements Staged/Extended (VMSES/E)" on page 46
- "Dump Viewing Facility" on page 46

Control Program (CP)

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 CMS component 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 VM system or on different 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 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.

Virtual Machines

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

- XA virtual machines are functionally equivalent to ESA virtual machines. The XA designation is supported for compatibility with previous versions of VM.
- 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.
- 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 XA, ESA, 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
XA[1], ESA	ESA/390	ESA/390 or z/Architecture[2]
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.

z/VM provides three types of virtual machines, which are 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 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 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 (CSE)

CSE is a function of z/VM that allows multiple 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

Inter-System Facility for Communications (ISFC)

ISFC is a function of CP that enables communication between programs written to the APPC/VM, CPI Communications, or IUCV programming interfaces. A group of interconnected 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 component interactively diagnoses virtual machine dumps. See "Dump Viewing Facility" on page 46.

VM Guest LAN

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

- Virtual adapters

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

- Connectivity for virtual adapters

  CP provides commands that enable VM users to connect virtual network adapters to an emulated Local Area Network (LAN) segment. Guests connected by an emulated LAN can communicate using the same software that would be used to communicate over an equivalent physical LAN segment.

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

Support for Hardware Architectures and Facilities

CP is the component of z/VM that provides support for hardware architectures and facilities, some of which are described here. Note that in many cases this support is available only to guests.

Asynchronous Data Mover Facility (ADMF)

CP provides guest support for 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:

- z/VM is running in basic mode (not in an LPAR)
- The PR/SM feature is available
- 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).

Enterprise Storage Server™ Large Volumes

z/VM 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.

Enterprise Systems Connection Architecture® (ESCON)

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 date 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-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 (FCP)

z/VM provides guest support for the FCP hardware channel. This channel allows an IBM zSeries server to connect to a fibre-channel fabric. The z/VM support allows guest operating systems to access selected devices on Small Computer System Interface (SCSI) controllers connected to the fabric.

Fibre Connection (FICON™) Channels

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 (FICON CTCA)

z/VM provides guest support for FICON 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.

Flash Copy

A native CP user or a guest can initiate the Flash Copy function to make an instant copy of a disk or data set from a source device to a target device on an IBM Enterprise Storage Server or other virtual DASD subsystem.

HiperSockets

z/VM 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 Input/Output (QDIO) high-speed I/O protocol.

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

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 Facility for Linux (IFL)

z/VM supports the IBM S/390 Integrated Facility for Linux (IFL), a hardware feature available on G5, G6, Multiprise 3000, and zSeries servers which provides additional processing capacity for Linux workloads. IFL is managed by PR/SM as a logical partition with dedicated CPs. 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 Processors Supported by VM" on page 79.

Move-Page Facility

CP provides support for V=V 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.

Guest Move-Page support is *not* available to:

- Guest virtual machines when z/VM is running in a logical partition
- A z/VM or VM/ESA guest of z/VM

Open Systems Adapter (OSA)

CP provides guest support for OSA-2 and OSA-Express hardware features, which provide connectivity to various types of networks. For more information, see "Open Systems Adapter Support Facility (OSA/SF)" on page 48.

Parallel Access Volumes

CP provides guest support for the Parallel Access Volumes feature of the IBM Enterprise Storage Server. This feature allows you to configure 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 allows concurrent I/O to a base volume and all of its associated alias volumes.

PCI Cryptographic Accelerator and Coprocessor

z/VM supports the IBM PCICA (PCI Cryptographic Accelerator) and the IBM PCICC (PCI Cryptographic Coprocessor) 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 VM system can include Linux guests using the RSA-Assist support simultaneously with other VM guests using the CMOS Cryptographic support.

Processor Resource/Systems Manager (PR/SM)

CP supports both basic mode and logically partitioned (LPAR) mode on processors with the PR/SM feature installed.

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 (QDIO) Facility
CP supports guest use of the QDIO Facility. The QDIO Facility 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.

Conversational Monitor System (CMS)

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*.

CMS Application Programming

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

- Extended architecture (XC) support
- CMS Pipelines
- Multitasking services
- Callable services library (CSL)
- OpenExtensions
- Reusable Server Kernel
- Assembler macros and functions
- OS/MVS simulation
- DOS/VSE support

For more information, see the *z/VM: CMS Application Development Guide*.

Shared File System (SFS)

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 (DFSMS/VM)" on page 47.

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 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*.

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 as a CMS client is used to send 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 in z/VM 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*.

OpenExtensions

OpenExtensions provides open systems support. This support consists of:
- OpenExtensions Services
- OpenExtensions Shell and Utilities

OpenExtensions Services includes the VM implementation of three 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

The POSIX.1, POSIX.1a, and POSIX.1c interfaces are provided as C library routines in the 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 run-time routines to provide the functions, but are also available to other applications. The CSL routines can be invoked as REXX functions through a REXX subcommand environment, ADDRESS OPENVM.

Also included in OpenExtensions Services is a POSIX.1-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.

OpenExtensions Shell and Utilities provides application development tools and an interactive environment in support of the POSIX application environment. OpenExtensions Shell and Utilities is the VM implementation of the POSIX 1003.2 Shell and Utilities standard (known as POSIX.2). Each of the POSIX.2 utilities additionally conforms to the X/Open Portability Guide, issue 4 (XPG4) for Commands and Utilities.

OpenExtensions Shell and Utilities provides a large set of utilities that aid in program development and in porting applications from other open systems. It also 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.

For more information, see the *z/VM: CMS Application Development Guide*.

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.

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

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 options
- Subcommands
- REXX statements
- Callable routines
- Pipelines stages
- Assembler language macros
- Messages

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*.

REXX/VM

REXX/VM contains the REXX/VM Interpreter, which processes the English-like REstructured eXtended eXecutor (REXX) programming language. It also contains the 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*.

Group Control System (GCS)

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*.

Transparent Services Access Facility (TSAF)

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*.

APPC/VM VTAM Support (AVS)

AVS is a VTAM application that provides communication 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 communication with:

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

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

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

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 EXEC 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*.

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: The VM Dump Tool interactively analyzes CP stand-alone dumps, CP ABEND dumps, and virtual machine dumps of a CP system, functions formerly performed by the Dump Viewing Facility. See "VM Dump Tool" on page 37.

Chapter 5. z/VM Additional Facilities

This chapter describes the additional facilities supplied with z/VM:

- "Data Facility Storage Management Subsystem for VM (DFSMS/VM)"
- "Language Environment for OS/390 & VM"
- "Open Systems Adapter Support Facility (OSA/SF)" on page 48
- "TCP/IP for z/VM" on page 48

Data Facility Storage Management Subsystem for VM (DFSMS/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*.

Language Environment for OS/390 & VM

Language Environment for OS/390 & VM provides the run-time environment for programs generated with participating high-level languages. Language Environment helps you create mixed-language applications and gives you a consistent method of accessing common, frequently-used services.

Language Environment consists of:

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

For more information, see the *Language Environment for OS/390 & VM: Concepts Guide*.

Open Systems Adapter Support Facility (OSA/SF)

Open Systems Adapter-2 (OSA-2) and 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). 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 the OSA/SF Windows 95, Windows NT, or OS/2 graphical user interface (GUI). For more information, see the *VM/ESA: Open Systems Adapter Support Facility User's Guide for OSA-2*.

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. With TCP/IP, z/VM systems can act as peers of other central computers in TCP/IP open networks. Applications can be shared transparently across VM, Linux for zSeries, and other environments. As shown in Figure 1 on page 49, users can send messages, transfer files, share printers, and access remote resources across a broad range of systems from multiple vendors.

TCP/IP can be characterized as belonging to one of the following categories:
- 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/management functions, which detect and solve network problems.
- Application Programming interfaces, which allow you to write your own client/server applications.
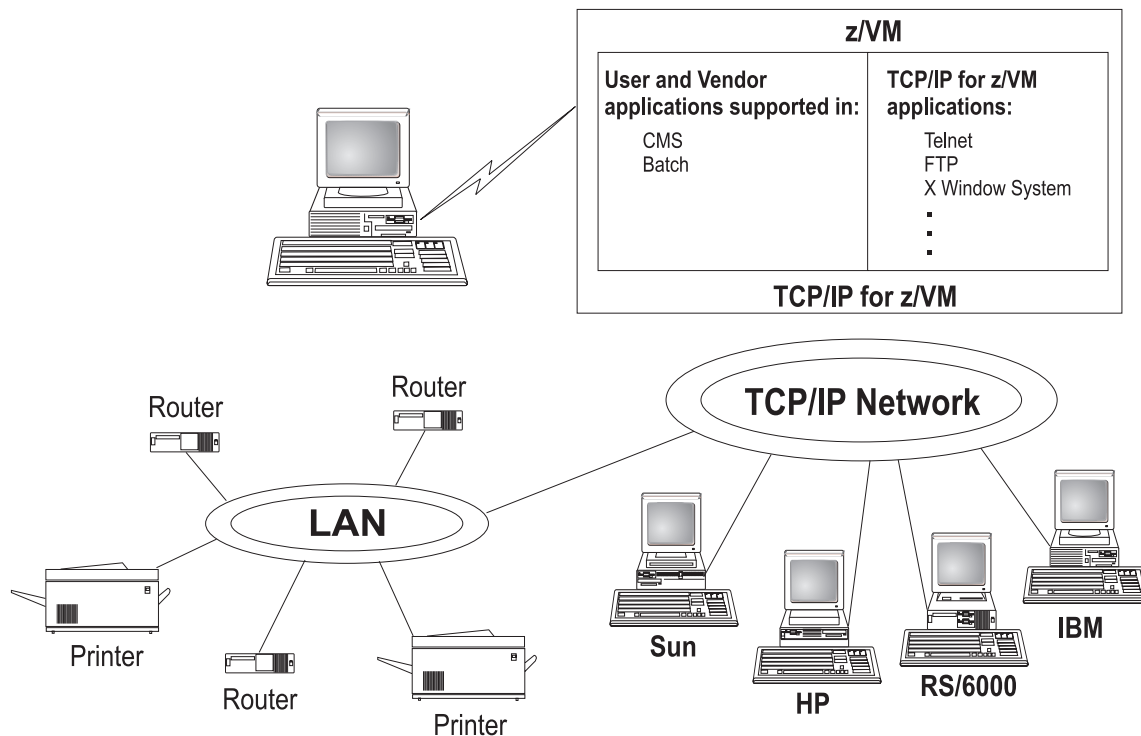
Figure 1. TCP/IP for z/VM as Part of a Multivendor Network

Transport Protocols

The transport layer of TCP/IP consists of transport protocols, which allow communication between application programs. This section describes the transport protocols in TCP/IP.

Transmission Control Protocol (TCP)

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 (UDP)

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

Applications are provided with the TCP/IP feature that 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. The following applications and protocols are included in TCP/IP:

- Telnet Protocol
- File Transfer Protocol (FTP)
- Trivial File Transfer Protocol (TFTP)
- Simple Mail Transfer Protocol (SMTP)
- Domain Name System (DNS)
- Simple Network Management Protocol (SNMP)
- Kerberos Authentication System
- Remote Printing (LPR and LPD)
- Dynamic Routing (RouteD)
- X Window System
- GDDMXD
- Remote Procedure Call (RPC)
- Network File System (NFS)
- Remote Execution Protocol (REXEC)
- Bootstrap Protocol (BOOTP)
- Dynamic Host Configuration Protocol (DHCP)
- Network Database System (NDB)
- Multiple Protocol Route (MPROUTE)
- Open Shortest Path First (OSPF)
- Secure Socket Layer (SSL)
- Internet Message Access Protocol (IMAP)
- Socket Interfaces

For more information, see the *z/VM: TCP/IP Level 430 User's Guide*.

Chapter 6. z/VM Optional Features

This chapter describes the optional features of z/VM:

- "Directory Maintenance Facility (DirMaint)"
- "Performance Reporting Facility (PRF)" on page 52
- "RealTime Monitor (RTM)" on page 52
- "Resource Access Control Facility for VM (RACF for VM)" on page 52

Directory Maintenance Facility (DirMaint)

DirMaint provides efficient and secure interactive facilities for maintaining your VM system directory. Directory management is simplified by DirMaint's command interface and automated facilities. DirMaint provides a corresponding command for every 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.

- 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 on password authorization strategy, see the *z/VM: Directory Maintenance Facility Function Level 410 Tailoring and Administration Guide*.

For more information, see:
- "Directory Maintenance Facility Restrictions" on page 29
- "Directory Maintenance Facility System Integrity" on page 31
- "Directory Maintenance Facility Security" on page 33

Performance Reporting Facility (PRF)

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*.

RealTime Monitor (RTM)

RTM is a realtime 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*.

Resource Access Control Facility for VM (RACF for VM)

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

To help each installation meet its unique security needs and objectives, RACF provides:
- Protection of installation-defined resources
- Flexible control of access to protected resources
- The ability to store information for other products

- A choice of centralized or decentralized control profiles
- Transparency to end users
- Exits for installation-written routines

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

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

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

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

For more information, see *RACF: General Information*.

Chapter 7. z/VM Library Guide

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

z/VM Internet Library

The z/VM Internet Library provides access to z/VM product publications in Adobe Portable Document Format (PDF) and IBM BookManager format. It 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

The address of the z/VM Internet Library is:

http://www.ibm.com/eserver/zseries/zvm/library/

VM Collection CD-ROM

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

Note: Only unlicensed books are included.

The *Online Library Omnibus Edition: 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.

z/VM Library Structure

This section explains how the z/VM library is organized.

Base Library

The z/VM base library contains books that describe the functions in the z/VM product base. The base library is organized according to the main tasks that computer users perform. These main tasks are:

Task	Definition
Evaluation	Deciding if z/VM meets your installation's needs.
Installation and Service	Generating and maintaining z/VM.
Planning and Administration	Making fundamental decisions about the options z/VM offers. 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.
Customization	Extending or enhancing z/VM.
Operation	Starting z/VM, monitoring it to keep it running, and shutting it down if required.
Application Programming	Designing, coding, compiling, running, debugging, and maintaining application programs to do specific functions.
End Use	Performing user tasks.
Diagnosis	Identifying the source of a programming problem, describing the problem, comparing it to similar known problems, reporting a new problem, and correcting the problem.

Other Groups of Books

Also included in the z/VM library are groups of books for the z/VM additional facilities and optional features:

- DFSMS/VM
- Language Environment for OS/390 & VM
- OSA/SF
- TCP/IP for z/VM
- DirMaint
- PRF
- RTM
- RACF for VM

Basic (Automatically Shipped) z/VM Documentation

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

- One copy of the *Online Library Omnibus Edition: VM Collection* CD-ROM
- One printed copy of each of the following books:
  - *z/VM: General Information*
  - *z/VM: Installation Guide*
  - *z/VM License Information*
  - *z/VM: Service Guide*
  - *z/VM: TCP/IP Level 430 Planning and Customization*

If the RACF for VM optional priced feature is ordered, one printed copy of each of the following books is supplied at no additional cost:

- *RACF: Command Language Reference*
- *RACF: Migration and Planning*
- *RACF: Security Administrator's Guide*
- *RACF: System Programmer's Guide*

Note: For any book included on the *Online Library Omnibus Edition: 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.

Abstracts of Books in the z/VM Base Library

This section describes the books in the z/VM base library. Each book is listed under its task group. The title of the book is followed by its publication number.

For abstracts of the other books in the z/VM library, see:

Evaluation: Deciding If z/VM Meets Your Needs

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, additional facilities, and optional features
- A library guide that describes the product documentation
- A list of the IBM processors that VM supports
- A list of the IBM operating systems supported as guests of VM
- A list of the IBM devices that VM supports

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 current z/VM library) you should obtain for additional information.

Installation and Service: Generating and Maintaining z/VM

z/VM: Installation Guide, GC24-5992

The *z/VM: Installation Guide* contains step-by-step procedures for installing z/VM. 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. The book also provides installation worksheets that you can use to plan your installation.

Included with this book is the *z/VM Installation and Service Summary* 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 your z/VM system. 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: Installation Guide* 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: Making Decisions and Defining Resources for z/VM

z/VM: CMS File Pool Planning, Administration, and Operation, SC24-5949

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 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: Dynamic I/O Configuration Planning and Administration, SC24-6044

z/VM: Dynamic I/O Configuration Planning and Administration describes how to plan for and use z/VM dynamic I/O configuration support. Dynamic I/O configuration allows you to add, delete, and modify the definitions of channel paths, control units, and I/O devices to both the server and z/VM without shutting down the system.

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/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.

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.

Customization: Extending or Enhancing z/VM

z/VM: CP Exit Customization, SC24-5953

z/VM: CP Exit Customization describes how to customize a z/VM system using CP exit points, both IBM-defined and customer-written. Topics include:
- Creating, controlling, and calling CP exit points
- Creating, controlling, and overriding CP commands
- Creating, controlling, and overriding DIAGNOSE codes
- Creating, controlling, and using local message repositories
- Dynamically loading into and unloading from CP storage
- Using dynamic CP exits

Operation: Starting, Running, and Shutting Down z/VM

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

Application Programming: Creating and Using Application Programs 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, SC24-5961

z/VM: CMS Application Multitasking describes how you can use CMS multitasking to develop and run multitasking application programs written in 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).

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

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.

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/VM: OpenExtensions Advanced Application Programming Tools, SC24-5979

z/VM: OpenExtensions Advanced Application Programming Tools provides advanced information for using the **lex**, **yacc**, and **make** utilities in the OpenExtensions Shell and 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 Language Environment 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 commands and utilities in the OpenExtensions Shell and Utilities. It also describes the OPENVM commands, which are used to obtain OpenExtensions services.

z/VM: OpenExtensions POSIX Conformance Document, GC24-5976

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 shell commands included in the OpenExtensions Shell and Utilities. 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*.

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.

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.

Debug Tool User's Guide and Reference, SC09-2137

The *Debug Tool User's Guide and Reference* is intended for application programmers using the Debug Tool to debug High Level Languages with Language Environment.

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*.

End Use: Performing z/VM User Tasks

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

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.

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.

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: 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: Identifying, Describing, Reporting, and Correcting Problems in z/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/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: 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.

Abstracts of Books for z/VM Additional Facilities

This section describes the books for the additional facilities supplied with z/VM. The title of the book is followed by its publication number.

For information about the current edition levels and available formats of these books, see "Editions and Formats of z/VM Books" on page 71.

DFSMS/VM

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

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: 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.

Language Environment for OS/390 & VM

z/VM: Language Environment 1.8 C Run-Time Library Reference, SC24-6038

The *z/VM: Language Environment 1.8 C Run-Time Library Reference* describes the C language header files, library functions, language extensions, and macros that operate with z/VM and Language Environment.

Language Environment for OS/390 & VM: Concepts Guide, GC28-1945

The *Language Environment for OS/390 & VM: Concepts Guide* provides information on evaluating and planning for Language Environment.

Language Environment for OS/390 & VM: Debugging Guide and Run-Time Messages, SC28-1942

The *Language Environment for OS/390 & VM: Debugging Guide and Run-Time Messages* 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. Also included are chapters on debugging HLL-specific routines and routines that run under CICS®.

Language Environment for OS/390 & VM: Programming Guide, SC28-1939

The *Language Environment for OS/390 & VM: 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- and operating system-specific information, where applicable.

Language Environment for OS/390 & VM: Programming Reference, SC28-1940

The *Language Environment for OS/390 & VM: 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.

Language Environment for OS/390 & VM: Run-Time Migration Guide, SC28-1944

The *Language Environment for OS/390 & VM: Run-Time Migration Guide* provides an overview of the steps required to migrate applications for use with this level of Language Environment. You may not necessarily be migrating to a new language

compiler. The information in the book is designed to help you create a broad migration strategy, helping you identify which modules can be migrated first, and which will require relinking or recompiling. It also explains how to use Language Environment run-time options to achieve behavior that is compatible with your old modules. Familiarity with the run-time libraries of the different languages, and an understanding of the basics of linking and running applications, are assumed.

Language Environment for OS/390 & VM: Writing Interlanguage Communication Applications, SC28-1943

Language Environment for OS/390 & VM: Writing Interlanguage Communication 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.

OSA/SF

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* describes the Open Systems Adapter-Express (OSA-Express) Gigabit Ethernet (GbE) feature for S/390 servers. It provides guidelines for using OSA/SF with the OSA-Express.

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 describes the Open Systems Adapter (OSA) hardware feature, the S/390 hardware and software platforms on which the OSA runs, and the networks that the OSA supports. The book discusses the planning required in the system hardware I/O configuration, in the OSA using the OSA Support Facility (OSA/SF), and in the TCP/IP and other host programs.

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 OSA/SF, a host-based tool for configuring and managing OSAs. You communicate with OSA/SF through the OSA/SF graphical user interface (GUI) or from CMS using OSA/SF commands.

zSeries 900: Open Systems Adapter-Express Customer's Guide and Reference, SA22-7476

The *zSeries 900: Open Systems Adapter-Express Customer's Guide and Reference* describes the Open Systems Adapter-Express (OSA-Express) Gigabit Ethernet (GbE) feature for IBM zSeries servers. It provides guidelines for using OSA/SF with the OSA-Express.

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

zSeries 900: Planning for the Open Systems Adapter-2 Feature describes the Open Systems Adapter (OSA) hardware feature, the IBM zSeries and S/390 hardware and software platforms on which the OSA runs, and the networks that the OSA supports. The book discusses the planning required in the system hardware I/O configuration, in the OSA using the OSA Support Facility (OSA/SF), and in the TCP/IP and other host programs.

TCP/IP for z/VM

z/VM: TCP/IP Level 430 Diagnosis Guide, GC24-6023

The *z/VM: TCP/IP Level 430 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 Level 430 Messages and Codes, GC24-6022

z/VM: TCP/IP Level 430 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: TCP/IP Level 430 Planning and Customization, SC24-6019

z/VM: TCP/IP Level 430 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.

z/VM: TCP/IP Level 430 Programmer's Reference, SC24-6021

The *z/VM: TCP/IP Level 430 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)

z/VM: TCP/IP Level 430 User's Guide, SC24-6020

The *z/VM: TCP/IP Level 430 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

Abstracts of Books for z/VM Optional Features

This section describes the books for the optional features of z/VM. The title of the book is followed by its publication number.

For information about the current edition levels and available formats of these books, see "Editions and Formats of z/VM Books" on page 71.

DirMaint

z/VM: Directory Maintenance Facility Function Level 410 Command Reference, SC24-6025

The *z/VM: Directory Maintenance Facility Function Level 410 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 Function Level 410 Messages, GC24-6026

z/VM: Directory Maintenance Facility Function Level 410 Messages provides the explanations, failing component names, and suggested corrective actions for the messages issued by DirMaint.

z/VM: Directory Maintenance Facility Function Level 410 Tailoring and Administration Guide, SC24-6024

The *z/VM: Directory Maintenance Facility Function Level 410 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.

PRF

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.

RTM

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.

RACF for VM

RACF: Auditor's Guide, SC28-1342

The *RACF: 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.

RACF: Command Language Reference, SC28-0733

The *RACF: Command Language Reference* describes the syntax and functions of RACF commands.

RACF: Command Language Reference Summary, SX22-0014

The *RACF: Command Language Reference Summary* shows the syntax of RACF commands.

RACF: Diagnosis Guide, GY28-1016

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

RACF: General Information, GC28-0722

RACF: General Information contains an overview of RACF and highlights the latest enhancements.

RACF: General User's Guide, SC28-1341

The *RACF: 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.

RACF: Macros and Interfaces, SC28-1345

RACF: 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*.

RACF: Messages and Codes, SC38-1014

RACF: Messages and Codes describes RACF messages, abend codes, manager return codes, and utility return codes.

RACF: Migration and Planning, GC23-3054

RACF: 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.

RACF: Security Administrator's Guide, SC28-1340

The *RACF: 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

RACF: System Programmer's Guide, SC28-1343

The *RACF: 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

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.

Editions and Formats of z/VM Books

The tables in this section identify the current edition and available formats for each book in the z/VM library. Table 4 on page 73 lists the base z/VM books. Table 5 on page 75 lists the books for the additional facilities provided with z/VM. Table 6 on page 76 lists the books for the z/VM optional features. The first edition of a book

for z/VM Version 4 has a new publication number. The current edition of a book is indicated by its publication number suffix, which is listed in the **Edition** column of the table. Books that are new or have new editions for z/VM 4.3.0 are identified with the NEW icon. Most z/VM books are available as Adobe PDF files and IBM BookManager files. Some books may also be available as printed books.

CD-ROM

The current edition of the *Online Library Omnibus Edition: VM Collection* is SK2T-2067-20.

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

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

Note: BookManager files are primarily intended for 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 for the z/VM base and z/VM additional facilities are supplied free with z/VM. "Basic" books for a z/VM optional priced feature are supplied only when the feature is ordered. See "Basic (Automatically Shipped) z/VM Documentation" on page 57. "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.

z/VM Base Books

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

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

Book Title	Number	Edition	PDF	BookMgr	Printed
z/VM: CMS Application Development Guide	SC24-6002	-00	Yes	Yes	
z/VM: CMS Application Development Guide for Assembler	SC24-6003	-00	Yes	Yes	
z/VM: CMS Application Multitasking	SC24-5961	-00	Yes	Yes	
z/VM: CMS Callable Services Reference	SC24-6004	-02 `NEW`	Yes	Yes	
z/VM: CMS Command and Utility Reference	SC24-6010	-02 `NEW`	Yes	Yes	
z/VM: CMS File Pool Planning, Administration, and Operation	SC24-5949	-00	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	
CMS/TSO Pipelines: Author's Edition	SL26-0018	-03		Yes	Extra
z/VM: CMS Planning and Administration	SC24-6042	-00 `NEW`	Yes	Yes	
VM/ESA: CMS Primer	SC24-5458	-02		Yes	Extra
z/VM: CMS User's Guide	SC24-6009	-00	Yes	Yes	
VM/ESA: Connectivity Planning, Administration, and Operation	SC24-5756	-00		Yes	Extra
z/VM: CP Command and Utility Reference	SC24-6008	-03 `NEW`	Yes	Yes	
z/VM: CP Exit Customization	SC24-5953	-00	Yes	Yes	
z/VM: CP Planning and Administration	SC24-6043	-00 `NEW`	Yes	Yes	
z/VM: CP Programming Services	SC24-6001	-02 `NEW`	Yes	Yes	
VM/ESA: CPI Communications User's Guide	SC24-5595	-01		Yes	Extra
z/VM: Diagnosis Guide	GC24-6039	-00	Yes	Yes	
z/VM: Dump Viewing Facility	GC24-5966	-00	Yes	Yes	
z/VM: Dynamic I/O Configuration Planning and Administration	SC24-6044	-00 `NEW`	Yes	Yes	
z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation	SC24-5965	-00	Yes	Yes	
z/VM: General Information	GC24-5991	-04 `NEW`	Yes	Yes	Basic
z/VM: Group Control System	SC24-5998	-02 `NEW`	Yes	Yes	
z/VM: Installation Guide	GC24-5992	-02 `NEW`	Yes[1]		Basic

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

Book Title	Number	Edition	PDF	BookMgr	Printed
z/VM License Information	GC24-6033	-03 `NEW`			Basic
z/VM: Migration Guide	GC24-5996	-02 `NEW`	Yes	Yes	
z/VM: OpenExtensions Advanced Application Programming Tools	SC24-5979	-00	Yes	Yes	
z/VM: OpenExtensions Callable Services Reference	SC24-6007	-00	Yes	Yes	
z/VM: OpenExtensions Command Reference	SC24-6006	-00	Yes	Yes	
z/VM: OpenExtensions POSIX Conformance Document	GC24-5976	-00	Yes	Yes	
z/VM: OpenExtensions User's Guide	SC24-6053	-00 `NEW`	Yes	Yes	
z/VM: Performance	SC24-5999	-02 `NEW`	Yes	Yes	
z/VM: Program Management Binder for CMS	SC24-6057	-00 `NEW`	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	-03 `NEW`	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	
z/VM: REXX/VM User's Guide	SC24-5962	-00	Yes	Yes	
z/VM: Running Guest Operating Systems	SC24-5997	-02 `NEW`	Yes	Yes	
z/VM: Saved Segments Planning and Administration	SC24-6056	-00 `NEW`	Yes	Yes	
z/VM: Service Guide	GC24-5993	-02 `NEW`	Yes	Yes	Basic
z/VM: System Administration Facility	SC24-6034	-01	Yes	Yes	
z/VM: System Messages and Codes - CMS	GC24-6031	-02 `NEW`	Yes	Yes	
z/VM: System Messages and Codes - CP	GC24-6030	-03 `NEW`	Yes	Yes	
z/VM: System Messages and Codes - Other Components	GC24-6032	-02 `NEW`	Yes	Yes	
z/VM: System Operation	SC24-6000	-01 `NEW`	Yes	Yes	
z/VM: Virtual Machine Operation	SC24-6036	-01 `NEW`	Yes	Yes	
z/VM: VM Dump Tool	GC24-6037	-00 `NEW`	Yes	Yes	
z/VM: VMSES/E Introduction and Reference	GC24-5994	-02 `NEW`	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	
Common Programming Interface Communications Reference	SC26-4399	-09	Yes	Yes [2]	Extra

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

Book Title	Number	Edition	PDF	BookMgr	Printed
Common Programming Interface Resource Recovery Reference	SC31-6821	-01		Yes	Extra
Debug Tool User's Guide and Reference	SC09-2137	-09 `NEW`	Yes	Yes	
OS/390: DFSMS Program Management	SC27-0806	-00	Yes	Yes	Extra
Notes on the z/VM Base:					
1. The PDF version of the *z/VM: Installation Guide* is not included on the *Online Library Omnibus Edition: VM Collection* CD-ROM.					
2. The latest BookManager version of the *Common Programming Interface Communications Reference* is SC26-4399**-08**.					

Books for z/VM Additional Facilities

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

Table 5. Current Editions and Available Formats of Books for z/VM Additional Facilities

Facility / Book Title	Number	Edition	PDF	BookMgr	Printed
DFSMS/VM					
z/VM: DFSMS/VM Function Level 221 Diagnosis Guide	GC24-6046	-00 `NEW`	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Customization	SC24-6047	-00 `NEW`	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Messages and Codes	GC24-6048	-00 `NEW`	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Planning Guide	SC24-6049	-00 `NEW`	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Removable Media Services	SC24-6050	-00 `NEW`	Yes	Yes	
z/VM: DFSMS/VM Function Level 221 Storage Administration	SC24-6051	-00 `NEW`	Yes	Yes	
Language Environment for OS/390 & VM					
z/VM: Language Environment 1.8 C Run-Time Library Reference	SC24-6038	-00	Yes	Yes	
Language Environment for OS/390 & VM: Concepts Guide	GC28-1945	-09	Yes	Yes	Extra
Language Environment for OS/390 & VM: Debugging Guide and Run-Time Messages	SC28-1942	-09	Yes	Yes	Extra
Language Environment for OS/390 & VM: Programming Guide	SC28-1939	-09	Yes	Yes	Extra
Language Environment for OS/390 & VM: Programming Reference	SC28-1940	-09	Yes	Yes	Extra
Language Environment for OS/390 & VM: Run-Time Migration Guide	SC28-1944	-09	Yes	Yes	Extra
Language Environment for OS/390 & VM: Writing Interlanguage Communication Applications	SC28-1943	-09	Yes	Yes	Extra
OSA/SF					

Table 5. Current Editions and Available Formats of Books for z/VM Additional Facilities (continued)

Facility / Book Title	Number	Edition	PDF	BookMgr	Printed
S/390: Open Systems Adapter-Express Customer's Guide and Reference	SA22-7403	-04	Yes	Yes	Extra
S/390: Planning for the S/390 Open Systems Adapter (OSA-1, OSA-2) Feature	GC23-3870	-08	Yes	Yes	Extra
VM/ESA: Open Systems Adapter Support Facility User's Guide for OSA-2	SC28-1992	-03		Yes	Extra
zSeries 900: Open Systems Adapter-Express Customer's Guide and Reference	SA22-7476	-01	Yes	Yes	
zSeries 900: Planning for the Open Systems Adapter-2 Feature	GA22-7477	-00	Yes	Yes	
TCP/IP for z/VM					
z/VM: TCP/IP Level 430 Diagnosis Guide	GC24-6023	-01 `NEW`	Yes	Yes	
z/VM: TCP/IP Level 430 Messages and Codes	GC24-6022	-01 `NEW`	Yes	Yes	
z/VM: TCP/IP Level 430 Planning and Customization	SC24-6019	-01 `NEW`	Yes	Yes	Basic
z/VM: TCP/IP Level 430 Programmer's Reference	SC24-6021	-01 `NEW`	Yes	Yes	
z/VM: TCP/IP Level 430 User's Guide	SC24-6020	-01 `NEW`	Yes	Yes	

Books for z/VM Optional Features

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

Table 6. Current Editions and Available Formats of Books for z/VM Optional Features

Feature / Book Title	Number	Edition	PDF	BookMgr	Print
DirMaint					
z/VM: Directory Maintenance Facility Function Level 410 Command Reference	SC24-6025	-02 `NEW`	Yes	Yes	
z/VM: Directory Maintenance Facility Function Level 410 Messages	GC24-6026	-02 `NEW`	Yes	Yes	
z/VM: Directory Maintenance Facility Function Level 410 Tailoring and Administration Guide	SC24-6024	-02 `NEW`	Yes	Yes	
PRF					
z/VM: Performance Reporting Facility Function Level 410	SC24-6027	-02 `NEW`	Yes	Yes	
RTM					
z/VM: RealTime Monitor Function Level 410	SC24-6028	-02 `NEW`	Yes	Yes	
RACF for VM					
RACF: Auditor's Guide	SC28-1342	-12		Yes	Extra
RACF: Command Language Reference	SC28-0733	-16		Yes	Basic

Table 6. Current Editions and Available Formats of Books for z/VM Optional Features (continued)

Feature / Book Title	Number	Edition	PDF	BookMgr	Print
RACF: Command Language Reference Summary	SX22-0014	-06			Extra
RACF: Diagnosis Guide	GY28-1016	-07 **NEW**	Yes	Yes	
RACF: General Information	GC28-0722	-18		Yes	Extra
RACF: General User's Guide	SC28-1341	-09		Yes	Extra
RACF: Macros and Interfaces	SC28-1345	-07		Yes	Extra
RACF: Messages and Codes	SC38-1014	-17		Yes	Extra
RACF: Migration and Planning	GC23-3054	-04		Yes	Basic
RACF: Security Administrator's Guide	SC28-1340	-12		Yes	Basic
RACF: System Programmer's Guide	SC28-1343	-11		Yes	Basic
External Security Interface (RACROUTE) Macro Reference for MVS and VM	GC28-1366	-08 **NEW**	Yes	Yes	

Appendix A. IBM Processors Supported by VM

This appendix provides information about the IBM processors supported by current VM operating systems. It addresses 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 VM" on page 83.

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

Term	Meaning
PR/SM	Processor Resource/Systems Manager. A hardware feature that supports LPAR mode and MPG capability.
LPAR	Logically Partitioned. On a processor with PR/SM operating in LPAR mode, processor resources are divided across up to fifteen logical partitions, depending on the processor model.
IFL	IBM S/390 Integrated Facility for Linux. A hardware feature that provides additional processing capacity for Linux workloads in a logical partition.
MPG	Multiple Preferred Guests. On a processor with PR/SM operating in basic mode, a VM host operating system supports up to six preferred (high performance) guests.
VM Data Spaces	A facility of all listed VM releases that allows an XC virtual machine to access as many as 1022 data spaces of 2GB (gigabytes) each. (An XC virtual machine requires an ESA/390 architecture or z/Architecture processor.)
S/370™	System/370 architecture
ESA/370	ESA/370 architecture
ESA/390	ESA/390 architecture
VM240	VM/ESA 2.4.0
VM310	z/VM 3.1.0
VM410	z/VM 4.1.0
VM420	z/VM 4.2.0
VM430	z/VM 4.3.0

The following general notes apply to the matrix:

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

Table 7. VM Processor Support Matrix

Processor	Mode	Current VM Support
ES/4381™-9x (1)	S/370	
	ESA/370	VM240
Notes on ES/4381-9x:		
(1) Storage Key Facility (SKF) and VM Data Spaces facility are not available on this processor.		
ES/3090™ E/S	S/370	
	ESA/370	VM240 (1)
	LPAR	VM240 (1,2)
Notes on ES/3090 E/S:		
(1) VM Data Spaces facility is not available.		
(2) On the ES/3090 E, CMS guest environments on a VM host running in an LPAR are supported for test and development only. On the ES/3090 S, RPQ 8P1367 is required to support production CMS guest environments on a VM host running in an LPAR.		
ES/3090 J	S/370	
	ESA/370	VM240 (1)
	LPAR	VM240 (1)
Notes on ES/3090 J:		
(1) VM Data Spaces facility is not available.		
ES/3090 9000T	S/370	
	ESA/370	VM240 (1)
	LPAR	VM240 (1)
Notes on ES/3090 9000T:		
(1) VM Data Spaces facility is not available.		
ES/9000® 9221	S/370	
	ESA/390	VM240
	LPAR	VM240
ES/9000 9121	ESA/390	VM240
	LPAR	VM240
ES/9000 9021	ESA/390	VM240
	LPAR	VM240
Note on ES/9000 9221, 9121, and 9021: For specific service levels required, contact your IBM representative.		
P/390, R390	Basic	VM240, VM310
Note on P/390, R390: For specific service levels required, contact your IBM representative.		
@server xSeries™ 430 Enabled for S/390 (x/EFS)	Basic	VM240, VM310
Note on x/EFS: For specific service levels required, contact your IBM representative.		

Table 7. VM Processor Support Matrix (continued)

Processor	Mode	Current VM Support
S/390 Multiprise 2000	Basic	VM240, VM310
	LPAR	VM240, VM310
Note on Multiprise 2000: For specific service levels required, contact your IBM representative.		
S/390 Multiprise 3000 Enterprise Server	Basic	VM240 (1), VM310, VM410, VM420, VM430
	LPAR	VM240 (1), VM310, VM410, VM420, VM430
	LPAR IFL	VM410 (2), VM420 (2), VM430 (2)
Notes on Multiprise 3000: For specific service levels required, contact your IBM representative. **(1)** APAR VM62180 is required. **(2)** CMS Level 17 or later, Linux for zSeries, Linux for S/390, z/VM 4.1.0 or later, and stand-alone utilities supplied with z/VM 4.1.0 or later run in LPAR IFL mode. ICKDSF requires APAR PQ46396.		
9672 R1	Basic	VM240
	LPAR	VM240
Note on R1: For specific service levels required, contact your IBM representative.		
9672 Parallel Enterprise Server R2/R3	Basic	VM240, VM310
	LPAR	VM240, VM310
Note on R2/R3: For specific service levels required, contact your IBM representative.		
9672 Parallel Enterprise Server Generation 3 (G3)	Basic	VM240 (1), VM310 (1)
	LPAR	VM240 (1), VM310 (1)
Notes on G3: For specific service levels required, contact your IBM representative. **(1)** The CMOS Cryptographic Processor is supported for use by guests.		
9672 Parallel Enterprise Server Generation 4 (G4)	Basic	VM240 (1,2), VM310 (1,2)
	LPAR	VM240 (1,2), VM310 (1,2)
Notes on G4: For specific service levels required, contact your IBM representative. **(1)** 370-mode operating systems will not run as guests of VM on this server. **(2)** The CMOS Cryptographic Processor is supported for use by guests.		
9672 Parallel Enterprise Server Generation 5 (G5)	Basic	VM240 (1,2), VM310 (1,2), VM410 (1,2), VM420 (1,2,4), VM430 (1,2,4)
	LPAR	VM240 (1,2), VM310 (1,2), VM410 (1,2), VM420 (1,2,4), VM430 (1,2,4)
	LPAR IFL	VM410 (3), VM420 (3,4), VM430 (3,4)

Table 7. VM Processor Support Matrix (continued)

Processor	Mode	Current VM Support
Notes on G5:		
For specific service levels required, contact your IBM representative.		
(1) 370-mode operating systems will not run as guests of VM on this server.		
(2) The CMOS Cryptographic Processor is supported for use by guests.		
(3) CMS Level 17 or later, Linux for zSeries, Linux for S/390, z/VM 4.1.0 or later, and stand-alone utilities supplied with z/VM 4.1.0 or later run in LPAR IFL mode. ICKDSF requires APAR PQ46396.		
(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.		
9672 Parallel Enterprise Server Generation 6 (G6)	Basic	VM240 (1,2), VM310 (1,2), VM410 (1,2), VM420 (1,2,4), VM430 (1,2,4)
	LPAR	VM240 (1,2), VM310 (1,2), VM410 (1,2), VM420 (1,2,4), VM430 (1,2,4)
	LPAR IFL	VM410 (3), VM420 (3,4), VM430 (3,4)
Notes on G6:		
For specific service levels required, contact your IBM representative.		
(1) 370-mode operating systems will not run as guests of VM on this server.		
(2) The CMOS Cryptographic Processor is supported for use by guests.		
(3) CMS Level 17 or later, Linux for zSeries, Linux for S/390, z/VM 4.1.0 or later, and stand-alone utilities supplied with z/VM 4.1.0 or later run in LPAR IFL mode. ICKDSF requires APAR PQ46396.		
(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.		
@server **zSeries 800 (z800)**	Basic	VM240 (1,2,3), VM310 (1,3), VM410 (1,3), VM420 (1,3,5), VM430 (1,3,5)
	LPAR	VM240 (1,2,3), VM310 (1,3), VM410 (1,3), VM420 (1,3,5), VM430 (1,3,5)
	LPAR IFL	VM410 (4), VM420 (4,5), VM430 (4,5)
@server **zSeries 900 (z900)**	Basic	VM240 (1,2,3), VM310 (1,3), VM410 (1,3), VM420 (1,3,5), VM430 (1,3,5)
	LPAR	VM240 (1,2,3), VM310 (1,3), VM410 (1,3), VM420 (1,3,5), VM430 (1,3,5)
	LPAR IFL	VM410 (4), VM420 (4,5), VM430 (4,5)
Notes on zSeries:		
For specific service levels required, contact your IBM representative.		
(1) 370-mode operating systems will not run as guests of VM on this server.		
(2) VM240 does not support the z/Architecture (64-bit) capabilities of the z800 or z900.		
(3) The CMOS Cryptographic Processor is supported for use by guests.		
(4) CMS Level 17 or later, Linux for zSeries, Linux for S/390, z/VM 4.1.0 or later, and stand-alone utilities supplied with z/VM 4.1.0 or later run in LPAR IFL mode. ICKDSF requires APAR PQ46396.		
(5) 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.		

Appendix B. IBM Operating Systems Supported as Guests of VM

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

In general, an operating system, version, or release is supported as a guest of VM only on hardware (processors, DASD, and other devices) for which support has been announced for that operating system, version, or release to run native, in an LPAR, or as a guest of 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 processor considerations, see Appendix A, "IBM Processors Supported by VM" on page 79.

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 VM image running in an LPAR will experience performance comparable to running as a guest of a VM system running natively. Several hardware assists available to VM running native are not available to VM in an LPAR. When 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 processor.

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: 1. Guest is supported in V=R virtual machine 2. Guest is also supported in V=F virtual machine if the real hardware has the PR/SM feature installed
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 8. VM Guest Support Matrix

Guest	Host	Support
Linux for S/390	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (1) VR UM ESA (1) VR UM ESA (2) VR UM ESA (2) VR UM ESA (2)

Notes for Linux for S/390 Guests:

(1) The 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, IBM zSeries 800, or IBM zSeries 900.

(2) The VM host must be running on one of the following: IBM S/390 Multiprise 3000 Enterprise Server, IBM Parallel Enterprise Server G5 or G6, IBM zSeries 800, or IBM zSeries 900.

Guest	Host	Support
Linux for zSeries	z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (1) VR UM ESA (1) VR UM ESA (1) VR UM ESA (1)

Notes for Linux for zSeries Guests:

(1) The z/VM host must be running on an IBM zSeries 800 or IBM zSeries 900 and the 64-bit CP image must be loaded.

Guest	Host	Support
OS/390 V2R6 - V2R9 (1)	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (2,3) VR UM ESA (2,3) VR UM ESA (2,4) VR UM ESA (2,4) VR UM ESA (2,4)
OS/390 V2R10 (1)	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (2,3) VR UM ESA (2,3) VR UM ESA (2,4) VR UM ESA (2,4) VR UM ESA (2,4)

Notes for OS/390 Guests:

(1) Exploitation of hardware function by OS/390 may require specific levels of VM. For details, see *OS/390: Planning for Installation*, GC28-1726.

(2) VM does not support external coupling facilities or real coupling links.

(3) 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 and later, IBM zSeries 800, and IBM zSeries 900. An entire sysplex environment can be defined on a single VM image. VM guest coupling simulation is intended for test and development environments only, not for production.

(4) z/VM 4.1.0 and later support guest-coupling simulation on IBM S/390 Multiprise 3000 Enterprise Server, IBM S/390 Parallel Enterprise Server G5 and G6, IBM zSeries 800, and IBM zSeries 900. An entire sysplex environment can be defined on a single VM image. VM guest coupling simulation is intended for test and development environments only, not for production.

Guest	Host	Support
z/OS V1 (1)	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (2,4,5) VR UM ESA (3,4,5) VR UM ESA (3,4,5) VR UM ESA (3,4,5) VR UM ESA (3,4,5)

Table 8. VM Guest Support Matrix (continued)

Guest	Host	Support
Notes for z/OS Guests:		
(1)	Exploitation of hardware function by z/OS may require specific levels of VM. For details, see *z/OS: Planning for Installation*, GA22-7504.	
(2)	The VM/ESA host must be running on an IBM S/390 Multiprise 3000 Enterprise Server or IBM S/390 Parallel Enterprise Server G5 or G6. The z/OS guest runs only in 31-bit mode on these servers. z/OS is not supported as a guest of VM/ESA on an IBM zSeries 800 or IBM zSeries 900.	
(3)	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, IBM zSeries 800, or IBM zSeries 900:	
	• On an IBM S/390 Multiprise 3000 Enterprise Server or IBM S/390 Parallel Enterprise Server G5 or G6, the z/OS guest runs only in 31-bit mode.	
	• On an IBM zSeries 800 or IBM zSeries 900, the z/OS guest must run in 64-bit mode on a 64-bit CP image.	
(4)	VM does not support external coupling facilities or real coupling links.	
(5)	VM supports guest-coupling simulation. An entire sysplex environment can be defined on a single VM image. VM guest coupling simulation is intended for test and development environments only, not for production.	
TPF V4R1 (1)	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM XA ESA VR UM XA ESA VR UM XA ESA VR UM XA ESA VR UM XA ESA
Notes for TPF Guests:		
(1)	TPF is supported as a guest of VM in environments where TPF-specific processor 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.	
VSE/ESA™ V2R4 - V2R6	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM XA ESA VR UM XA ESA VR UM XA ESA VR UM XA ESA VR UM XA ESA
VM/ESA 2.4.0	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (1,2,3) VR UM ESA (2,3) VR UM ESA (2,3) VR UM ESA (2,3) VR UM ESA (2,3)
z/VM 3.1.0	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (2,3,4,5) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6)
z/VM 4.1.0	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (2,3,4,5) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6)
z/VM 4.2.0	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (2,3,4,5) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6)

Table 8. VM Guest Support Matrix (continued)

Guest	Host	Support
z/VM 4.3.0	VM/ESA 2.4.0 z/VM 3.1.0 z/VM 4.1.0 z/VM 4.2.0 z/VM 4.3.0	VR UM ESA (2,3,4,5) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6) VR UM ESA (2,3,4,6)

Notes for VM Guests:

(1) ESA/390 SIE extensions required for VM Data Spaces are not available to guests on ESA/370 processors.

(2) V=R recovery is not supported for a V=R guest.

(3) VM Guest Coupling Simulation will not work in the VM guest.

(4) A z/VM guest is supported only on servers that z/VM supports natively. See Appendix A, "IBM Processors Supported by VM" on page 79.

(5) The z/VM guest runs only in 32-bit mode.

(6) The z/VM guest can run in 64-bit mode only on a 64-bit CP image on an IBM zSeries 800 or IBM zSeries 900.

Appendix C. IBM Devices Supported by VM

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

The device support matrix is intended to provide a quick reference for support of various devices on VM. You should also check the hardware device support list for your processor 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 VM unless otherwise indicated. VM supports devices at any of the following three levels of function:

1. **Full support:** VM uses the device itself and makes it available to guests. VM will usually manage the device on behalf of all users.

2. **Dedicated to a guest or virtual machine:** VM does not use the device itself but enables 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:** VM does not use the device itself but will allow a full function guest or application in a virtual machine to use it. 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 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 VM release, the corresponding *virtual* device remains supported in the same or later 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. VM's 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,

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

VM does not support 7-track tapes.

The following terms are used in the device support matrix:

Term	Meaning
VM240	VM/ESA 2.4.0
VM310	z/VM 3.1.0
VM410	z/VM 4.1.0
VM420	z/VM 4.2.0
VM430	z/VM 4.3.0

Direct Access Storage Devices (DASD)

Table 9. Device Support List—DASD

Device	VM Releases Providing Support	Support Notes
3370 Model A01, B01, A02, B02	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.
3375 Model A1, B1, D1	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.
3380 Model A04, AA4, B04, AD4, BD4, AE4, BE4, AJ4, BJ4, AK4, BK4	VM240, VM310, VM410, VM420, VM430	Not supported for VM430 installation.
3380 Model CJ2	VM240, VM310, VM410, VM420, VM430	Not supported for VM430 installation.
3390 Model A14, A18, B14, B18, B1C, A24, A28, B24, B28, B2C	VM240, VM310, VM410, VM420, VM430	Supported in 3390 mode (native mode) with VSE/VSAM 2.1.0 or later. Mixed 3390 models are not supported for VM430 installation.
3390 Model A34, A38, B34, B38, B3C	VM240, VM310, VM410, VM420, VM430	Supported in 3390 mode (native mode) with VSE/VSAM 2.1.0 or later. Mixed 3390 models are not supported for VM430 installation.
3390 Model A94, A98, B94, B98, B9C	VM240, VM310, VM410, VM420, VM430	Not supported for 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	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a guest as a 3088. Not supported for VM installation.

Table 9. Device Support List—DASD (continued)

Device	VM Releases Providing Support	Support Notes
3995 Model 151, 111 Optical Library Dataserver	VM240, VM310, VM410, VM420, VM430	Must be defined as a 3390. Not supported for VM installation. 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 153, 113 Optical Library Dataserver	VM240, VM310, VM410, VM420, VM430	Must be defined as a 3390. Not supported for VM installation. Intended as a mass-storage device. Should not be used for system data or for data for applications that require high performance DASD.
9332 Model 400, 402, 600, 602	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.
9335 Model B01	VM240, VM310, VM410, VM420, VM430	Not supported for installation of VM310 or later.
9336 Model 010, 020, 025	VM240, VM310, VM410, VM420, VM430	Not supported for installation of VM410 or later.
9340 Direct Access Storage Subsystem: 9345 Model B12, B22	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.
RAMAC® Array DASD: 9391 Model A10 Rack with 9392 Model B13 Drawers	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	Emulates a 3990 Model 3 Storage Control with 3390 Models 1, 2, and 3 DASD or 3380 Models J and K DASD. Supported for VM430 installation only when emulating a 3390. Mixed 3390 models are not supported for VM430 installation.
RAMAC Array Subsystem: 9394 Model 001, 002, or 003 Cluster Array Controller with 9395 Model B13 or B23 Drawers	VM240, VM310, VM410, VM420, VM430	Emulates a 3990 Model 2 Storage Control with 3390 Model 3 DASD or 3380 Model K DASD. Supported for VM430 installation only when emulating a 3390. Mixed 3390 models are not supported for VM430 installation.
Internal Disk (for Multiprise 2000)	VM240, VM310	This device is a feature of the S/390 Multiprise 2000 server. Emulates a 3990 Model 2 Storage Control with 3390 Models 1, 2, 3, and 9 DASD or 3380 Models E, J, and K DASD. 3390 Model 9 is not supported for VM installation.

Table 9. Device Support List—DASD (continued)

Device	VM Releases Providing Support	Support Notes
Internal Disk (for Multiprise 3000)	VM240, VM310, VM410, VM420, VM430	This device is a feature of the S/390 Multiprise 3000 Enterprise Server. Emulates a 3990 Model 2 Storage Control with 3390 Models 1, 2, 3, and 9 DASD or 3380 Models E, J, and K DASD. 3390 Model 9 is not supported for VM installation. Supported for VM430 installation only when emulating a 3390 Model 1, 2, or 3. Mixed 3390 models are not supported for VM430 installation. On VM240, APAR VM62180 is required. The performance-oriented track level commands are supported for guest use only. IOCP APAR VM62312 is required. ICKDSF APAR PQ26800 is required.

Table 9. Device Support List—DASD (continued)

Device	VM Releases Providing Support	Support Notes
Enterprise Storage Server (2105 DASD Subsystem)	VM240, VM310, VM410, VM420, VM430	Supported only in emulation mode. Must be defined as 3990 Model 3 or 6 Storage Control with either of the following: • 3390 Models 2, 3, and 9 DASD • 3390 Models 2 and 3 DASD in 3380 track compatibility mode 3390 Model 9 is not supported for VM installation. Mixed 3390 models are not supported for VM430 installation. On VM240, APAR VM62111 is required. The performance-oriented track level commands are supported for guest use only. To use the Parallel Access Volumes feature, the device must be dedicated to a guest. On VM240, APAR VM62295 is required. On VM240, APAR VM62416 is required to support guest Flash Copy (dedicated DASD or fullpack minidisk). On VM310 or later, guest and native Flash Copy are supported. To support more than 10017 cylinders on a 3390 Model 9: • On VM310 CP, APAR VM62767 is required if CSE XLINK minidisks are used. • On VM310, VM410, or VM420 CMS, APAR VM62936 is required. • On VM310 GCS, APAR VM62937 is required. • On DFSMS/VM Function Level 221, APAR VM63004 is required. • On DirMaint 1.5.0 or DirMaint Function Level 410, APAR VM62907 is required. ICKDSF APAR PQ26800 is required.

DASD Control Units and Storage Controls

Table 10. Device Support List—DASD Control Units and Storage Controls

Device	VMESA Releases Providing Support	Support Notes
3830 Model 2	VM240, VM310, VM410, VM420, VM430	
3880 Model 1, 3, 4	VM240, VM310, VM410, VM420, VM430	

Table 10. Device Support List—DASD Control Units and Storage Controls (continued)

Device	VMESA Releases Providing Support	Support Notes
3880 Model E21, G21, H21, J21, D23, E23, G23, H23, J23	VM240, VM310, VM410, VM420, VM430	
3990 Model 1, 2	VM240, VM310, VM410, VM420, VM430	
3990 Model 3	VM240, VM310, VM410, VM420, VM430	Concurrent Copy function supported for guest use only.
3990 Model 6	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	
9335 Model A01	VM240, VM310, VM410, VM420, VM430	
9340 Direct Access Storage Subsystem: 9341 Model A02 9343 Model C02, C04	VM240, VM310, VM410, VM420, VM430	
9340 Direct Access Storage Subsystem: 9343 Model D04	VM240, VM310, VM410, VM420, VM430	ESCON-attached only.
9340 Direct Access Storage Subsystem: 9343 Model CC2, CC4	VM240, VM310, VM410, VM420, VM430	Models CC2 and CC4 are cache models (basic caching only). The cache function is not visible to or controllable by software. No additional VM support is required.
9340 Direct Access Storage Subsystem: 9343 Model DC4	VM240, VM310, VM410, VM420, VM430	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 VM support is required.

Tape Units and Tape Libraries

Table 11. Device Support List—Tape Units and Tape Libraries

Device	VM Releases Providing Support	Support Notes
2440	VM240, VM310, VM410, VM420, VM430	Must be defined as a 3420 Model 4. Not supported for VM installation.
3420 Model 3, 4, 5, 6, 7, 8	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.
3422 Tape Unit and Control	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.
3424 Tape Subsystem	VM240, VM310, VM410, VM420, VM430	For Brazil only. Not supported for VM installation.
3430	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.
3480 Tape Subsystem	VM240, VM310, VM410, VM420, VM430	Non-XF not supported for VM430 installation.
3490 Tape Subsystem	VM240, VM310, VM410, VM420, VM430	

Table 11. Device Support List—Tape Units and Tape Libraries (continued)

Device	VM Releases Providing Support	Support Notes
3490E (Enhanced Capability Model) Tape Subsystem	VM240, VM310, VM410, VM420, VM430	
3494 Tape Library Dataserver and Virtual Tape Server	VM240, VM310, VM410, VM420, VM430	Native support is provided in conjunction with DFSMS/VM. Not supported for VM installation. VM310 or later supports Peer-to-Peer VTS and VTS Import/Export feature for guests.
3495 Tape Library Dataserver	VM240, VM310, VM410, VM420, VM430	Native support is provided in conjunction with DFSMS/VM. Not supported for VM installation.
3590 High Performance Tape Subsystem	VM240, VM310, VM410, VM420, VM430	On VM240 or VM310, APAR VM62710 is required to support native FICON attachment of the 3590 A60 tape controller. Not supported for VM240, VM310, VM410, or VM420 installation.
9348 Model 11, 12	VM240, VM310, VM410, VM420, VM430	Not supported for VM installation.

Tape Control Units

Table 12. Device Support List—Tape Control Units

Device	VM Releases Providing Support	Support Notes
3803 Model 1, 2	VM240, VM310, VM410, VM420, VM430	
9221 DASD/Tape Subsystem Control	VM240	

Printers

Table 13. Device Support List—Printers

Device	VM Releases Providing Support	Support Notes
3203 Model 5	VM240, VM310, VM410, VM420, VM430	
3262	VM240, VM310, VM410, VM420, VM430	
3268 Model 2, 2C	VM230, M240, VM310, VM410, VM420, VM430	Must be defined as a 3287.
3287 Model 1, 1C, 2, 2C, 4	VM240, VM310, VM410, VM420, VM430	
3289 Model 1, 3, 4, 8	VM240, VM310, VM410, VM420, VM430	
3800 Model 1	VM240, VM310, VM410, VM420, VM430	
3800 Model 3, 6, 8	VM240, VM310, VM410, VM420, VM430	Full support in Model 1 compatibility mode or using Advanced Function Printing™ (AFP™) licensed programs.

Table 13. Device Support List—Printers (continued)

Device	VM Releases Providing Support	Support Notes
3812	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	Full support through VM/VTAM, using AFP licensed programs.
3825	VM240, VM310, VM410, VM420, VM430	Full support using AFP licensed programs.
3827	VM240, VM310, VM410, VM420, VM430	Full support using AFP licensed programs.
3835	VM240, VM310, VM410, VM420, VM430	Full support using AFP licensed programs.
3900	VM240, VM310, VM410, VM420, VM430	Must be defined as a 3800.
4245 Model 1	VM240, VM310, VM410, VM420, VM430	Supported as a 4245 or in 3262 compatibility mode.
4245 Model 12, 20	VM240, VM310, VM410, VM420, VM430	
4248 Model 1, 2	VM240, VM310, VM410, VM420, VM430	Supported as a 4248 or in 3211 compatibility mode.
6262 Model 14, 22	VM240, VM310, VM410, VM420, VM430	Must be defined as a 4248 Model 1.

Card Readers and Card Punches

Table 14. Device Support List—Card Readers and Card Punches

Device	VM Releases Providing Support	Support Notes
3505 Model B1, B2	VM240, VM310, VM410, VM420, VM430	
3525 Model P1, P2, P3	VM240, VM310, VM410, VM420, VM430	

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.

Display Printers

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

Display Control Units

Table 15. Device Support List—Display Control Units

Device	VM Releases Providing Support	Support Notes
2074 Console Support Controller	VM240, VM310, VM410, VM420, VM430	
3174	VM240, VM310, VM410, VM420, VM430	
3272 Model 2	VM240, VM310, VM410, VM420, VM430	
3274	VM240, VM310, VM410, VM420, VM430	
3276 Display/Control Unit	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device.

Communications Controllers

Table 16. Device Support List—Communications Controllers

Device	VM Releases Providing Support	Support Notes
3705	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device.
3720	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	

Enterprise Systems Connection Architecture (ESCON) Devices

Table 17. Device Support List—Enterprise Systems Connection Architecture (ESCON) Devices

Device	VM Releases Providing Support	Support Notes
9032 ESCON Director Model 2	VM240, VM310, VM410, VM420, VM430	
9032 ESCON Director Model 3	VM240, VM310, VM410, VM420, VM430	
9032 ESCON Director Model 5	VM240, VM310, VM410, VM420, VM430	
9033 ESCON Director Model 1	VM240, VM310, VM410, VM420, VM430	
9033 ESCON Director Model 4	VM240, VM310, VM410, VM420, VM430	
9034 ESCON Converter Model 1	VM240, VM310, VM410, VM420, VM430	
9035 ESCON Converter Model 2	VM240, VM310, VM410, VM420, VM430	
ESCON Channel-to-Channel Adapter (CTCA)	VM240, VM310, VM410, VM420, VM430	Extended mode operation only.

Table 17. Device Support List—Enterprise Systems Connection Architecture (ESCON) Devices (continued)

Device	VM Releases Providing Support	Support Notes
Note: VM supports ESCON channels, ESCON-attached control units, and the ESCON Director (ESCD) on all IBM zSeries servers, IBM S/390 Parallel Enterprise Servers, IBM S/390 Multiprise servers, and IBM ES/9000 processors, plus those IBM ES/3090 processors on which the ESCON hardware is supported. 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 processors that have parallel channels. For more information about ESCON architecture, see *Introducing Enterprise Systems Connection*, GA23-0383.		

Miscellaneous Devices

Table 18. Device Support List—Miscellaneous Devices

Device	VM Releases Providing Support	Support Notes
CTCA	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device.
FICON CTCA	VM310, VM410, VM420, VM430	Must be dedicated to a guest as a supported device. On VM310, VM410, or VM420, APAR VM62906 is required.
HiperSockets	VM420, VM430	Must be dedicated to a virtual machine as a supported device. On VM420, APAR VM62938 is required. APAR PQ51738 is required for TCP/IP Level 420.
OSA-2	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device. 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 VM guest. OSA/SF for VM can be run as a CMS application. OSA-2 is recognized as TYPE=OSA.

Table 18. Device Support List—Miscellaneous Devices (continued)

Device	VM Releases Providing Support	Support Notes
OSA Express	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device. 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 VM guest. OSA/SF for VM can be run as a CMS application. OSA Express is recognized as TYPE=OSE for the OSA Express Fast Ethernet and OSA Express 155 ATM modes. OSA Express is recognized as TYPE=OSD for the OSA Express Gigabit Ethernet mode.
PCI Cryptographic Accelerator	VM420, VM430	Must be dedicated to a Linux guest as a supported device. On VM420, APAR VM62905 is required. APAR VM62933 is required for DirMaint Function Level 410.
PCI Cryptographic Coprocessor	VM420, VM430	Must be dedicated to a Linux guest as a supported device. On VM420, APAR VM62905 is required. APAR VM62933 is required for DirMaint Function Level 410.
3088	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device.
3088 Model 61 PSCA Card (common link access to workstations)	VM240, VM310, VM410, VM420, VM430	
3172 Model 1, 2, 3	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device.
3174 Model 12L, 22L	VM240, VM310, VM410, VM420, VM430	
3737 Remote Channel-to-Channel Unit Model 2	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device. Must be defined as a CTCA.
3890™	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a guest as a supported device.
4753 Network Security Processor	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a guest as a supported device.

Table 18. Device Support List—Miscellaneous Devices (continued)

Device	VM Releases Providing Support	Support Notes
7171 Device Attachment Control Unit	VM240, VM310, VM410, VM420, VM430	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	VM240, VM310, VM410, VM420, VM430	Must be dedicated to a virtual machine as a supported device. Supported by TCP/IP for VM and TCP/IP for z/VM.

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