

z/VM
built on IBM Virtualization Technology



General Information

version 5 release 4

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Note:

Before using this information and the product it supports, read the information in “Notices” on page 107.

This edition applies to version 5, release 4, modification 0 of IBM z/VM (product number 5741-A05) and to all subsequent releases and modifications until otherwise indicated in new editions.

This edition replaces GC24-6095-07.

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About this document

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

- Base product and optional features
- How z/VM can help you
- What is new or changed in this release
- Hardware and software requirements
- Guide to the z/VM product information
- IBM servers, guest operating systems, and devices supported by current z/VM releases

Intended audience

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

Where to find more information

You can obtain more information about z/VM from the documents described in Chapter 7, “z/VM library guide,” on page 67.

Links to other online documents

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Chapter 1. Introducing z/VM

z/VM provides a highly flexible test and production environment on the IBM System z™ platform. The z/VM implementation of IBM virtualization technology provides the capability to run full-function operating systems such as Linux® on System z, z/OS®, z/VSE™, z/TPF, and z/VM as “guests” of z/VM. z/VM supports 64-bit IBM z/Architecture® guests and 31-bit IBM Enterprise Systems Architecture/390 guests.

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

Control Program (CP)

CP is a hypervisor and real-machine resource manager.

Conversational Monitor System (CMS)

CMS provides a high-capacity application and interactive user environment and provides the z/VM file systems.

TCP/IP for z/VM

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

Advanced Program-to-Program Communication/Virtual Machine (APPC/VM) Virtual Telecommunications Access Method (VTAM®) Support (AVS)

AVS provides connectivity in an IBM Systems Network Architecture (SNA) network.

Dump Viewing Facility

Dump Viewing Facility interactively diagnoses z/VM system problems.

Group Control System (GCS)

GCS is a virtual machine supervisor that provides multitasking services and supports a native SNA network.

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

HCD and HCM provide a comprehensive I/O configuration management environment.

Language Environment® for z/VM

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

Open Systems Adapter Support Facility (OSA/SF)

OSA/SF is a tool for customizing the modes of operation of OSA hardware features.

REXX/VM

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

Transparent Services Access Facility (TSAF)

TSAF provides communication services within a collection of z/VM systems without using VTAM.

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

VMSES/E provides a tools suite for installing and servicing z/VM and other enabled products.

For more information, see Chapter 5, “z/VM base product,” on page 41.

z/VM also offers the following optional features:

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

DFSMS/VM controls data and storage resources.

Directory Maintenance Facility for z/VM (DirMaint™)

DirMaint provides interactive facilities for managing the z/VM user directory.

Performance Toolkit for VM™

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

Resource Access Control Facility (RACF®) Security Server for z/VM

RACF provides data security for an installation by controlling access to it.

Remote Spooling Communications Subsystem (RSCS) Networking for z/VM

RSCS enables users to send messages, commands, files, and jobs to other users in a network.

For more information, see Chapter 6, “z/VM optional features,” on page 61.

z/VM virtualization technology provides guest support

z/VM provides each 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, memory, networking, and input/output (I/O) resources.

Operating systems and application programs can run in virtual machines as guests. For example, you can run multiple Linux and z/OS images on the same z/VM system that is also supporting various applications and end users. As a result, development, testing, and production environments can share a single physical computer.

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 an operating system can be generated and tested at the same time that the existing release is performing production work. This enables the new release to be installed and put into production more quickly. The ability to operate multiple operating systems concurrently under z/VM might 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 an operating system can be done at the same time normal production operations are in progress.
- **Provide backup facilities for the primary operating system.** A generated z/VM system is not model-dependent and can operate on various server models as long as the minimum hardware requirements are present. This enables a smaller

server model that has less real storage, fewer channels, fewer direct access devices, and fewer unit record devices than a larger server model to provide backup for the larger model (normally at a reduced level of performance).

- **Perform operator training concurrently with production work processing.** The real machine does not have to be dedicated to training additional or new operators or to providing initial training when a new operating system is installed. Operator errors cannot cause termination of real machine operations.
- **Simulate new system configurations before the installation of additional channels and I/O devices.** The relative load on channels and I/O devices can be determined using the simulated I/O configuration rather than the real I/O configuration. Experience with generating and operating an I/O configuration for multiple guests can be obtained using one real machine.
- **Test customer-written system exits.** Customer-written system exits can be tested without disrupting production work.

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

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

- Integrity and security:
 - z/VM supports guest use of the cryptographic facilities provided by supported IBM servers.
 - IBM will correct any integrity exposures introduced by unauthorized programs into the system.
 - Secure Sockets Layer (SSL) support is provided through TCP/IP for z/VM.
 - Integrated access control and authentication services can be augmented with the addition of an external security manager (ESM), such as the RACF Security Server for z/VM.
- Availability and reliability:
 - Application recovery: z/VM provides services which permit recovery of incomplete interactions with resource managers.
 - Automated operations: z/VM offers several levels of automated system management support. One example is the Programmable Operator. For a higher degree of automation, IBM Operations Manager for z/VM can be added.
 - z/VM provides duplexed data with transparent ongoing synchronization between the primary and backup copy, and automatic transparent switching to the backup copy in case of an error in the primary copy.
 - Online configuration changes eliminate many previously-required outages.
 - z/VM systems can be connected for improved server and user availability.
 - Fast restart reduces the end user impact of any outage.

z/VM supports application development and deployment

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

- APL2[®]
- Assembler
- C
- C++
- COBOL
- FORTRAN

Introduction

- Language Environment
- MQSeries® Client (WebSphere® MQ)
- PASCAL
- PL/I
- REXX
- Systems Application Architecture® (SAA®) common programming interface (CPI)
- VisualAge® Generator

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

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

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

z/VM application programming interfaces (APIs) include:

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

Special facilities are available to CMS applications, such as:

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

Note: Although IBM VSE/VSAM, V6.1 (5686-081), was withdrawn from marketing on September 30, 2005, CMS DOS/BAM will continue to provide its current level of function in support of DOS simulation and VSE/VSAM.

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

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

z/VM is accessible by people with disabilities

The following features support use by people with disabilities:

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

Introduction

Chapter 2. How z/VM V5.4 can help you

z/VM V5.4 is designed to extend its System z virtualization technology leadership by exploiting more capabilities of System z servers, including:

- Greater flexibility, with support for the new z/VM-mode logical partitions, allowing all System z processor-types (CPs, IFLs, zIIPs, zAAPs, and ICFs) to be defined in the same z/VM LPAR for use by various guest operating systems
- Capability to install Linux on System z from the HMC, which eliminates the need for any external network setup or a physical connection between an LPAR and the HMC
- Enhanced physical connectivity by exploiting all OSA-Express3 ports, helping service the network and reducing the number of required resources
- Dynamic memory upgrade support that allows real memory to be added to a running z/VM system, avoiding the need to shut down z/VM and its guests, deactivate the LPAR, change its memory allocation, reactivate the LPAR, re-IPL z/VM, and restart its guests. Memory can be added non-disruptively to individual guests that support the dynamic memory reconfiguration architecture.

The operation and management of virtual machines has been enhanced with new systems-management APIs, improvements to the algorithm for distributing a guest's share of the hardware processor among the guest's virtual processors, and usability enhancements for managing a virtual network.

Security capabilities of z/VM V5.4 provide an upgraded LDAP server at the functional level of the z/OS V1.10 IBM Tivoli® Directory Server for z/OS and enhancements to the RACF Security Server to create LDAP change log entries in response to updates to RACF group and user profiles, including user passwords and password phrases. The z/VM SSL server now operates in a CMS environment, instead of requiring a Linux distribution, thus allowing encryption services to be deployed more quickly and helping to simplify installation, service, and release-to-release migration.

The z/VM hypervisor is designed to help clients extend the business value of mainframe technology across the enterprise by integrating applications and data while providing exceptional levels of availability, security, and operational ease. z/VM virtualization technology is designed to provide the capability for clients to run hundreds to thousands of Linux servers in a single mainframe, together with other System z operating systems such as z/OS, or as a large-scale Linux-only enterprise-server solution. z/VM V5.4 can also help to improve productivity by hosting non-Linux workloads such as z/OS, z/VSE, and z/TPF.

z/VM V5.4 is intended to address the following situations:

- **Running more Linux server images on a single System z server.** Considerably more images than are currently supported by the LPAR mode of operation can be achieved with z/VM guest support. These Linux on System z server images can be deployed on standard processors (CPs) or IFL processors with z/VM V5.4. Running multiple Linux images on an IFL-configured z/VM system might not increase the IBM software charges of your existing System z environment. You can add z/VM V5.4 running on IFL processors to your existing z/OS, z/VM, z/TPF, z/VSE, or Linux on System z environment without increasing IBM software costs on the standard processors (CPs).
- **Moving selected Linux, Windows®, and UNIX® workloads to a single System z server.** Moving workloads while maintaining distinct server images and current

z/VM can help you

LAN topology can help reduce systems management complexity. By managing large server farms deployed on virtual servers instead of using multiple hardware servers, the number of real hardware servers and associated physical LANs might be reduced, which might lead to cost savings. Deploying Linux workloads on z/VM V5.4 might be particularly attractive if they interact with applications or data located on the same System z server.

- **Enhancing virtual networking.** z/VM virtual switch support provides external connectivity for guest LANs through an OSA-Express adapter without requiring a z/VM or Linux router virtual machine.
- **Consolidating operating systems on the System z platform.** z/VM V5.4 offers extensive scalability support for CPUs, memory, I/O, and networking, making it easier to consolidate workloads on a single z/VM image. This support is provided for both ESA/390 and z/Architecture guest operating systems, such as Linux on System z, TPF, z/TPF, z/OS, VSE/ESA™, and z/VSE.
- **Migrating to newer releases of z/OS.** z/VM can provide added flexibility for migration and testing, as well as for production.
- **Enhancing guest Parallel Sysplex® support.** The exploitation of z/Architecture might enable addressability to larger amounts of real and virtual memory, allowing the development and testing of 64-bit Parallel Sysplex applications in a guest environment.

For the most current information on z/VM, see the z/VM Web site at www.ibm.com/servers/eserver/zseries/zvm/.

Chapter 3. What is new or changed in z/VM V5.4

This section provides an overview of the new functions, enhancements, and other changes included in z/VM V5.4.

Note: Some program updates might be provided through z/VM service by program temporary fixes (PTFs) for authorized program analysis reports (APARs), which also might be available for some prior z/VM releases.

The changes are described under the following topics:

- “Improved scalability and constraint relief”
- “Virtualization technology and Linux enablement” on page 10
- “Network virtualization” on page 11
- “Security” on page 13
- “Systems management” on page 14
- “Application enablement” on page 15
- “Installation, service, and packaging changes” on page 16

For planned future changes to z/VM, see “Statement of direction” on page 18.

See *z/VM: Migration Guide* for information about changes to existing external interfaces to support the enhancements and changes in this release. It also includes information about the enhancements and changes in previous z/VM releases.

Improved scalability and constraint relief

This section describes enhancements that can help support increased workloads on z/VM.

Virtual memory performance enhancements

Moving specific CP data structures above the first 2 GB of main storage reduces contiguous-frame allocation searches for requests in the first 2 GB. This might help improve performance and scalability for systems with more than 2 GB of storage, particularly those supporting large virtual storage environments.

Expanded shared memory addressability

The constraint has been removed that restricted a discontinuous saved segment (DCSS) to being defined below 2047 MB of virtual storage. DCSSs can now reside anywhere within the first 512 GB of guest storage. While any one DCSS still cannot exceed 2047 MB in size, a guest system may use multiple DCSSs to access shared memory greater than 2047 MB in total. For example, this helps to allow many DCSSs to be used together to provide larger sizes needed for Linux filesystems, block devices, and shared objects.

IBM is working with its Linux distribution partners to include support for this function in future Linux on System z distributions.

Dynamic memory upgrade

System z servers provide a dynamic storage-reconfiguration capability to change the amount of main storage available for use in a logical partition (LPAR) while the

New or changed

partition is active. The configuration of storage for an LPAR includes an initial amount of main storage, plus an additional reserved amount, defined in fixed-size increments. The reserved storage can be assigned and accessed on demand, using the dynamic storage-reconfiguration function.

The new z/VM dynamic memory-upgrade capability exploits this system architecture for its own use and also virtualizes it for guest use.

Storage can be added to a z/VM configuration when:

- Another LPAR is deactivated
- Storage exists that is not currently assigned to any active LPAR
- Another LPAR releases storage
- Additional main storage is installed

The LPAR customization process can assign storage to an LPAR as *initial* or as *reserved* increments. Reserved storage in an LPAR is further separated by z/VM into *standby* and *reserved* storage. z/VM can increase the size of its main storage dynamically by bringing online designated amounts of standby storage. In addition, z/VM guests that support dynamic storage reconfiguration can dynamically increase and decrease their amounts of main storage.

z/VM does not support the release of real storage. Once storage has been added to a running z/VM configuration, it cannot be removed without a z/VM system shutdown, LPAR deactivation and reactivation, and z/VM system IPL.

Virtualization technology and Linux enablement

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

Increased flexibility with support for z/VM-mode partitions

The IBM System z10™ introduces z/VM-mode LPARs, which allow multiple types of System z processors to be defined in the same z/VM LPAR, including:

- Central Processor (CP)
- Integrated Facility for Linux (IFL)
- IBM System z10 Integrated Information Processor (zIIP)
- IBM System z10 Application Assist Processor (zAAP)
- Internal Coupling Facility (ICF)

z/VM V5.4 expands its guest support for specialty processors to allow these processor types to be defined as virtual CPUs. This new capability increases flexibility and simplifies systems management by allowing a single z/VM V5.4 system to, for example:

- Operate z/TPF, z/VSE, and z/OS guests on CPs
- Operate Linux on System z as guests on IFLs and optionally on CPs
- Offload z/OS system software process requirements, such as DB2® workloads, on zIIPs
- Provide an economical Java™ execution environment under z/OS on zAAPs
- Operate coupling facility virtual machines in support of a Parallel Sysplex test environment on ICFs and optionally on CPs

This support is exclusive to z/VM V5.4 and the IBM System z10 and satisfies the statement of direction made in the Hardware Announcement dated February 26, 2008.

Dynamic virtual processor management

z/VM V5.4 removes one of the consequences of stopped virtual processors for virtual processor prioritization. Prior to z/VM V5.4, a guest's CPU share was distributed equally among its virtual processors by dividing its share value by the number of non-dedicated virtual processors in the configuration, regardless of whether the virtual processors were in a stopped or started state. z/VM V5.4 performs share redistribution whenever a virtual processor is started or stopped, and no longer includes stopped virtual processors in the calculation of how much share to distribute to each virtual processor. The share redistribution also continues to occur in z/VM V5.4, as in previous releases, at the time a SET SHARE command is issued or when the number of defined virtual processors is altered.

Linux on System z provides a daemon (`cpuplugd`) that automatically starts and stops virtual processors based on virtual processor utilization and workload characteristics, exploiting z/VM V5.4 dynamic virtual processor management. The `cpuplugd` daemon is available with SuSE Linux Enterprise Server (SLES) 10 SP2. IBM is working with its Linux distribution partners to provide this function in other Linux on System z distributions.

Capability to dump Linux guests to SCSI

z/VM V5.4 provides the capability to dump Linux on System z guests to FCP-attached Small Computer System Interface (SCSI) disks. Compared with other methods like VMDUMP or dump to extended count key data (ECKD™) disks, this new capability might provide the following advantages:

- More guest virtual memory can be dumped because SCSI disks can be larger than ECKD disks.
- Dumping on SCSI disks avoids the need to convert a VMDUMP into a Linux tool format.
- The same SCSI dump mechanism now can be used when running Linux in a logical partition and in a z/VM virtual machine.

This new function works cooperatively with the SCSI Linux system dumper and can be used to generate system dumps that can be viewed by the Linux dump analysis tools **crash** or **lcrash**.

Network virtualization

This section describes enhancements to z/VM network virtualization.

More efficient transmission of network data

TCP/IP for z/VM V5.4 dynamically discovers the Maximum Transmission Unit (MTU) size of a given IPv4 or IPv6 Internet or intranet path. This helps to reduce fragmentation along the path, thus minimizing wasted network resources and helping to improve throughput by sending datagrams at the path MTU size. This function is automatically enabled for all IPv6 links and optionally can be enabled for IPv4 links.

Enhanced physical connectivity by exploiting all OSA-Express3 ports

z/VM V5.4 recognizes all four ports on an OSA-Express3 Gigabit Ethernet (GbE) machine feature. There are two PCI Express (PCI-E) adapters per feature, with two ports per adapter, for a total of four ports per feature. This capability was announced in the Hardware Announcement dated May 6, 2008.

Activating all four ports on an OSA-Express3 feature provides more physical connectivity to service the network and reduces the number of required resources (I/O slots, I/O cages, fewer CHPIDs to define and manage). With double the port density, reduced latency, and improved throughput, OSA-Express3 GbE is designed to satisfy the demands of bandwidth-hungry applications.

Four-port exploitation is also supported by z/VM V5.2 and z/VM V5.3 with the PTFs for APARs VM64277 and PK50120. If the PTFs are not applied, only two of the four ports will be “visible” to z/VM V5.2 and V5.3.

Enhanced connectivity with TCP/IP Layer 2 support

The Queued Direct Input/Output (QDIO) device driver of the TCP/IP stack can now operate in Layer 2 (of the Open Systems Interface (OSI) reference model) mode. The stack now deploys its own unique locally defined Media Access Control (MAC) addresses instead of sharing the OSA MAC address. It sends and receives Ethernet frames when transferring data through the OSA feature. Layer 2 support can be employed with an OSA-Express, OSA-Express2, or OSA-Express3 feature when configured in QDIO mode (CHPID type OSD).

This new support allows connecting a z/VM TCP/IP stack to an IPv4 or IPv6 Layer 2 virtual switch. You can also connect a z/VM TCP/IP stack to a Layer 2 guest LAN or connect a z/VM TCP/IP stack (via a real OSA-Express) to a physical LAN segment in Layer 2 mode. A z/VM TCP/IP stack connected to a virtual switch operating in Layer 2 mode is now supported in Link Aggregation configurations. Virtual switch Link Aggregation is designed to provide both increased bandwidth and more continuous network connectivity.

By default, TCP/IP now automatically restarts OSD and HiperSockets™ devices without requiring operator, network, or system-programmer intervention. This can help provide faster recovery of connectivity in the system

Enhanced ease of use in network management

The usability of managing virtual networks, including the z/VM virtual switch, has been enhanced:

- The QUERY LAN command has a new USERID option that provides a subset of the output of the QUERY LAN DETAILS command for the specified user.
- The QUERY VSWITCH command has two new options, USERID and RDEV, that display a subset of the output of the QUERY VSWITCH DETAILS command for the specified user or device.
- The QUERY VSWITCH command response includes the status of the VLAN_COUNTERS option in force for the specified VLAN-aware virtual switch.
- Detailed transmission counters can be turned on for a VLAN-aware virtual switch with the SET VSWITCH command and the MODIFY VSWITCH configuration statement.

In addition, a new SNMPTRAP utility can be used to generate SNMP TRAP messages, providing unsolicited data messages that are sent by an SNMP agent to

its SNMP managing system. These messages are usually used to inform the managing station about a special condition that has occurred either in an agent system or in the network.

TELNET server and client IPv6 support

The TCP/IP stack in z/VM V5.4 provides an IPv6-capable TELNET server and client. Because TELNET is written in Pascal, IPv6-capable Pascal APIs are also provided.

Security

This section describes enhancements to the security characteristics of z/VM.

Enhanced z/VM SSL server now CMS-based

The z/VM V5.3 Linux-based SSL server is not available with z/VM V5.4 and is being replaced with a CMS-based server with the PTF for APAR PK65850. This PTF is planned to be available in December, 2008. Instead of having an SSL server that requires a Linux distribution, a CMS-based SSL server might enable encryption services to be deployed more quickly and can help make installation, service, and release-to-release migration simpler. Other enhancements to the z/VM V5.4 SSL server include:

- Network-free SSL server administration
The SSL server can be managed without requiring a network connection between the SSL server administrator and the SSL server.
- New encryption and decryption engine
The SSL server uses z/OS V1.10 System SSL technology for encryption, decryption, and certificate management.
- New certificate-management services
The System SSL **gskkyman** utility is now used to manage the SSL server certificate database. New services available for the SSL server include certificate renewal, certificate signing, and certificate exportation with or without the private key. The **gskkyman** application also manages certificates for the z/VM LDAP server.

LDAP upgrade and RACF password change logging

In order to help maintain cross-platform consistency, the z/VM LDAP server introduced in z/VM V5.3 has been upgraded to the function level of the z/OS V1.10 IBM Tivoli Directory Server for z/OS. The z/VM RACF Security Server feature has been enhanced to create LDAP change log entries in response to updates to RACF group and user profiles, including changes to user passwords and password phrases. This update enables password changes made on z/VM to be more securely propagated to other systems, including z/OS, using applications such as the IBM Tivoli Directory Integrator.

Common Criteria certification

IBM has completed the activities required for the certification of z/VM V5.3 with the RACF Security Server optional feature for conformance to the Controlled Access Protection Profile (CAPP) and Labeled Security Protection Profile (LSPP) of the Common Criteria standard for IT security, ISO/IEC 15408, at Evaluation Assurance Level 4, augmented by flaw remediation procedures (EAL4+). This satisfies the statement of direction made in the Software Announcement dated February 6, 2007.

New or changed

z/VM V5.4 has not been evaluated for conformance, but is designed to meet the same standards.

Systems management

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

Further systems management enhancements for Linux and other virtual images

The z/VM virtual systems management application programming interface (API) is provided for System z platform provisioning applications (such as IBM Director and programs developed by non-IBM solution providers) for ease of use in creating and managing large numbers of Linux and other virtual system images running on z/VM.

The multitasking-capable sockets-based servers, introduced in z/VM V5.3, have been updated to communicate among themselves using shared queues. This helps to improve the speed of request processing, enhance error recovery, and increase the scalability of the systems management API.

In addition to the updated servers, enhancements provided in z/VM V5.4 include:

- New APIs to:
 - Grant users access to a virtual network LAN, and to determine which users have been authorized
 - Add, delete, and query virtual processors in an active virtual image's configuration or directory
 - Manage profile directory entries
 - Accept and validate password phrases
 - Query the level of the systems management API to determine what functions are available
 - Allow a sort ordinal to be defined for local tags in directory entries
- Enhancements to existing functions to:
 - Allow creation and deletion of virtual network LANs to be either persistent or temporary
 - Increase the length of a virtual image's local tag to 1024 characters

In z/VM V5.3, the sockets-based server replaced the Remote Procedure Call (RPC) server and CSL routines that were used to call the virtual systems management API in previous releases of z/VM. The RPC server is still available in z/VM V5.4, with all of the functions that were available in z/VM V5.2. However, the enhancements provided since z/VM V5.2 are not available through the RPC server, and no further enhancements are planned. Documentation on the use of the API with the RPC server and CSL routines was not updated and is not included in the z/VM V5.3 or V5.4 bookshelf. As stated previously in the Software Announcement dated February 6, 2007, IBM intends to remove the RPC server from a future z/VM release.

Directory manager enhancements

The IBM Directory Maintenance Facility (DirMaint) has been upgraded to a new function level (FL540) in z/VM V5.4. This new function level of DirMaint includes support for:

- End-user authentication using the end-user's password phrase, if one is defined in an external security manager (ESM)

- An end-user to use DirMaint to set a password phrase in the ESM
- Simplified DirMaint configuration, to enable the coordinated user and resource management in the RACF Security Server

Enhancements to the Performance Toolkit

The Performance Toolkit for VM feature has been upgraded to a new function level (FL540) for z/VM V5.4 and has been enhanced to:

- Display an optional “Banner” page that can be customized and is presented prior to displaying the Performance Toolkit logon page that provides access to the Web interface
- Provide updated displays and reports to support new monitor data for the dynamic memory upgrade enhancement
- Enable the SYSTEM (FCX102) and PRIVOPS (FCX104) reports to be generated using monitor data, allowing them to be produced in BATCH and MONSCAN modes

Enhancements to IBM Tivoli OMEGAMON XE on z/VM and Linux

IBM Tivoli OMEGAMON® XE on z/VM and Linux, V4.1.2 (5698-A36), provides statistical information about z/VM operating system resources, such as CPU, I/O, networking, memory, and DASD, as well as workload measurements. Performance information for Linux on System z guests of z/VM is also provided for tuning these Linux workloads and assessing the impact of these workloads on z/VM. Tivoli OMEGAMON XE on z/VM and Linux helps you minimize the time and costs associated with managing this multifaceted computing environment and achieve your goals for high availability. OMEGAMON XE for z/VM and Linux, V4.1.2, provides insight into workload performance on both z/VM and Linux on System z. Performance information collected from both environments from the Performance Toolkit for VM and Tivoli OMEGAMON agents is integrated into a unified view.

V4.1.2 of the z/VM agent provides system programmers with:

- Additional integrated monitoring of virtual disk (VDISK) control unit cache and DASD device cache assists in identifying bottlenecks in the I/O subsystem.
- Wait statistics due to processor spin locks help in discovering impacts due to spin locks.

IBM Tivoli OMEGAMON XE on z/VM and Linux, V4.1.2, supports all currently supported z/VM releases as well as z/VM V5.4 at its availability on September 12, 2008.

For additional information on IBM Tivoli OMEGAMON XE on z/VM and Linux, see the Web site at www.ibm.com/software/tivoli/products/omegamon-xe-linux-zseries/

Application enablement

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

Updated C/C++ for z/VM compiler

IBM XL C/C++ for z/VM, version 1 (5654-A22) release 2, is an advanced optimizing compiler for the z/VM platform. Based on industry standards, this professional programming tool can be used for developing large, complex, computationally intensive applications. It includes:

New or changed

- Support for the C99 programming standard
- A higher OPTIMIZE(3) or Opt(3) optimization level
- -qarch(4) and -qtune(4) compiler options to control the code being generated by the compiler
- Improved optimization with the high order transformation option and aligned keyword

C/C++ programs can be compiled and executed on CMS, which creates portability between z/VM and z/OS C/C++ programs. C/C++ source files can be read from a CMS minidisk, the CMS shared file system (SFS), or the byte file system (BFS), and output can be written to any of these file systems.

IBM XL C/C++ for z/VM can be ordered standalone or through the z/VM V5.4 SDO. The XL C/C++ for z/VM compiler executes only on z/VM V5.4 and can be licensed only to operate on standard processors (CPs). Applications compiled with the C/C++ compiler can be run on standard processors or Integrated Facility for Linux (IFL) processors. For more information on IBM XL C/C++ for z/VM, V1.2, see the Software Announcement dated August 5, 2008.

Language Environment upgrade

To support the IBM XL C/C++ for z/VM compiler and provide updated runtime libraries for C/C++, COBOL, and PL/I, the Language Environment component of z/VM V5.4 has been updated to the level shipped with z/OS V1.9.

Binder upgrade

The Program Management Binder for CMS has been updated to the level shipped with z/OS V1.9 MVS™ Program Management.

Installation, service, and packaging changes

This section describes changes to the z/VM installation and service processes and how z/VM is packaged (what facilities are provided with z/VM or offered as features).

Installation of Linux on System z from the HMC

Using z/VM V5.4 and the Hardware Management Console (HMC) 2.10.0 in conjunction with the Support Element (SE) 2.10.0 on the IBM System z10, z/VM can be installed in an LPAR, and both z/VM and Linux on System z can be installed in a virtual machine from the HMC DVD drive. This can eliminate requiring any external network setup and a physical connection between an LPAR and the HMC, instead using the existing communication path between the HMC and the SE. This might make configuration easier and more secure because the HMC does not have to reside on the intranet.

Note: This support is intended for customers who have no alternative, such as a LAN-based server, for serving the DVD contents for Linux installations. The elapsed time for installation using the HMC DVD drive can be an order of magnitude, or more, longer than the elapsed time for LAN-based alternatives.

This support is exclusive to z/VM V5.4 and the IBM System z10 and is an initial step toward satisfying the z/VM requirements of the statement of direction made in the Hardware Announcement dated February 26, 2008.

Also stated in the Hardware Announcement dated February 26, 2008, IBM plans to provide future support for z/VM hypervisor-configuration tasks from the HMC.

Installation and service enhancements

The installation process for z/VM V5.4 has been changed to provide more information to determine the installation status, including:

- Saving consoles at the end of each installation exec
- Copying console files from the first-level user IDs to the installed-system's minidisks

An alternative process was added that installs a second-level z/VM image by uploading the contents of the installation DVDs to minidisk, thus allowing such an installation without the use of a server. Because this process is slower than using an FTP server, it should be used **only** when the FTP capability is not available.

The VMSES/E SERVICE command has been updated to accept a file containing a list of components for which to build service. The VMSES/E LOCALMOD command has been updated to accept a file listing serviceable parts that will be modified or for which the local modification will be removed.

Electronic delivery of z/VM

The z/VM base operating system is available for Internet delivery from ShopzSeries at www.ibm.com/software/ShopzSeries/.

z/VM V5.4 Information Center

IBM now publishes the z/VM V5.4 documentation (information for the z/VM base and optional features) in an information center using the IBM Eclipse Help System framework. Publishing in an information center is in addition to z/VM product documentation published in IBM BookManager® and Adobe PDF formats and available through the *z/VM Collection* CD-ROM and DVD, the z/VM Internet Library, and the IBM Publications Center. The content of the z/VM V5.4 Information Center is identical to that in the traditional BookManager and PDF formats; however, the presentation might differ to some degree.

Advantages of information centers are:

- Content is indexed by Google and other Internet search engines to help locate information more easily.
- Custom searches can be created that include only the information you need for a particular task or job role.

The z/VM V5.4 Information Center is planned to be available on September 12, 2008:

- On an IBM Web site, at publib.boulder.ibm.com/infocenter/zvm/v5r4/index.jsp
- On a DVD, which allows you to install the z/VM V5.4 Information Center on a workstation or intranet. The DVD can be ordered (for a fee) from the IBM Publications Center using form number SK5T-7098.

IBM Online Library: z/VM Collection on CD-ROM Not Distributed

The distribution of the *IBM Online Library: z/VM Collection* on CD-ROM as a no-charge deliverable has been discontinued with z/VM V5.4. One copy of the *IBM Online Library: z/VM Collection on DVD* will be supplied at no additional charge with

New or changed

each z/VM V5.4 order. Both the CD-ROM and the DVD are available (for a fee) from the IBM Publications Center, at www.elink.ibm.com/publications/servlet/pbi.wss.

Withdrawal of distribution medium

z/VM V5.4 will not be available on the 3480 tape medium, satisfying the statement of direction made in the Software Announcement dated February 6, 2007.

Simultaneous with this withdrawal, 3490 Tape Subsystems will not be supported for installation by z/VM. z/VM continues to be distributed on 3590 and 3592 tape media, on DVDs, and by Internet delivery through ShopzSeries. Effective November 5, 2008, service on 3480 and 3490E tape media for all z/VM releases is planned to be discontinued from ShopzSeries.

Also, distribution of the Recommended Service Update (RSU) on CD-ROM in Optical Media Attachment/2 (OMA/2) format has been discontinued for all currently supported and future z/VM releases. SERVLINK files (virtual tape images) will continue to be delivered on the RSU CD-ROM.

Changes to the z/VM System Delivery Offering (SDO)

With the general availability of z/VM V5.4, the following changes have been made to the z/VM V5.4 SDO:

- Removed shipment of the SDO Enabling Aid with the product order. The Enabling Aid is planned to be available by September 12, 2008, at www.ibm.com/vm/sdo/sdozvm54.html. Just click on “z/VM SDO Enabling Aid” to download the files.
- Removed Host Management Facility (HMF), V1.1 (5684-157), from the V5.4 SDO. HMF was announced to be withdrawn from marketing effective September 8, 2008, in the Withdrawal Announcement dated June 3, 2008.
HMF is replaced by IBM Operations Manager for z/VM, version 1 (5697-J10) release 2.0, or later.
- Removed VisualAge Generator Server for MVS, VM, and VSE, V1.2 (5648-B02), from the V5.4 SDO. VisualAge Generator Server for MVS, VM, and VSE, V1.2, was withdrawn from marketing effective June 3, 2008, in the Withdrawal Announcement dated June 3, 2008.
- Removed RSCS, V3.2 (5684-096), from the V5.4 SDO. RSCS V3.2 was withdrawn from marketing effective May 26, 2008, in the Withdrawal Announcement dated December 4, 2007.

Withdrawal of support for TCP/IP for z/VM functions

IBM is discontinuing service support for the Network Database (NDB) system, Trivial File Transfer Protocol (TFTP) server, X25 interface (including the X25IPI server), and SNALINK server and interface on z/VM V5.4. This satisfies the statement of direction made in the Software Announcement dated February 6, 2007.

Statement of direction

- **TCP/IP functions:** IBM intends to withdraw support in a future z/VM release for the Kerberos Authentication System.
- **MMC (Mainframe to Micro Channel[®]) card:** IBM intends to withdraw support in a future z/VM release for the MMC card, which enabled communication between the PS/2 (PWSCS) and VM (PWSCF or ISFC).

- **z/VM FlashCopy® enhancements:** IBM intends to enhance z/VM FlashCopy capabilities to support the FlashCopy SE function of the IBM DS8000™ with the PTF for APAR VM64449 in the fourth quarter of 2008. FlashCopy SE offers a space-efficient snapshot capability that reduces the storage capacity needed for point-in-time copies. This function is especially useful for short-lived testing or backups, such as flash to intermediate volume for backup to tape.

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

Chapter 4. Technical information

This section provides technical information about z/VM V5.4. It contains the following topics:

- “Hardware and storage requirements”
- “Device support” on page 24
- “Software (program) requirements” on page 25
- “Limitations and restrictions” on page 31
- “Performance considerations” on page 32
- “Operating systems supported as guests” on page 32
- “Other programs supported on z/VM” on page 32
- “National language support” on page 32
- “Packaging and ordering information” on page 33
- “Object code only and limited source availability” on page 34
- “Integrity and security” on page 34

Note: Some technical information might have changed since the publication of this edition. There might be a later edition of this publication. For the latest product updates, you should contact your IBM Support Center or visit the z/VM Web site at www.ibm.com/servers/eserver/zseries/zvm/.

Hardware and storage requirements

This section identifies the hardware and storage required to install and operate z/VM V5.4. It includes the following topics:

- “Server requirements”
- “Installation requirements”
- “Storage requirements” on page 22
- “CSE hardware requirements” on page 22
- “OSA/SF hardware requirements” on page 23
- “Performance Toolkit hardware requirements” on page 23
- “TCP/IP hardware requirements” on page 23
- “VM Guest RSA-Assist Support for Linux hardware requirements” on page 24

Server requirements

z/VM V5.4 operates on IBM System z servers, which support the IBM 64-bit z/Architecture. See Appendix A, “IBM servers supported by z/VM,” on page 87.

Specific server facilities are also required. See the architecture level set information at www.ibm.com/eserver/zseries/zvm/zvm540/architecture/.

Installation requirements

z/VM V5.4 is available in the following formats:

- DASD Dump/Restore (DDR) image on magnetic tape
- Binary image on DVD

To install z/VM:

- You need a local non-SNA 3270 terminal to use as a console, such as:

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- IBM Open Systems Adapter Integrated Communications Controller (OSA-ICC)
- Integrated 3270 console provided through the Hardware Management Console (HMC) on certain IBM servers
- IBM 2074 Console Support Controller
- IBM 3174 Control Unit
- Installation from magnetic tape requires a tape drive capable of reading IBM 3590 or 3592 tape cartridges.
- Installation from DVD requires the HMC, V1.8 or later.
- Installation to ECKD DASD requires IBM 3390 Model 3 or Model 9 DASD, or DASD that is defined to emulate these specific models.

Note: For performance reasons, IBM does not recommend using the original IBM 3390 Model 9. This recommendation does not apply to 3390 Model 9 DASD defined on RAID technology subsystems such as IBM System Storage DASD.

- Installation to FCP-attached SCSI LUNs requires IBM System Storage SCSI disks or equivalent.

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

Storage requirements

The amount of memory (storage) required to install and operate z/VM depends on several factors, such as the settings in the system configuration file, the environment where you plan to run, and the workload you want to run. Some guidelines for installation are:

- Installation first level from tape might require 256 MB of real memory.
- Installation first level from DVD requires that a minimum of 576 MB of real memory is assigned to the LPAR where z/VM will be installed.
- Installation second level (from tape or DVD) requires a minimum of 64 MB of virtual memory for the installation user ID on your first level system.

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

z/VM can support up to 256 GB of real memory and more than 1 TB of total virtual memory in use by guests. The actual amount of usable real and virtual memory is dependent on the amount of real memory in the z/VM logical partition; the hardware server model, firmware level, and configuration; and the number of guests and their workload characteristics.

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

CSE hardware requirements

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

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

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

OSA/SF hardware requirements

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

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

A full list of OSA and OSA/SF hardware requirements is beyond the scope of this document. See one of the following documents:

- *eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature*
- *System z10, System z9 and eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*

Performance Toolkit hardware requirements

The Performance Toolkit for VM requires general disk space and additional space on each user's A-disk, depending on the size of the log files to be written.

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

TCP/IP hardware requirements

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

- IBM 3172 Interconnect Controller with the Interconnect Controller Program (ICP), version 3 (5621-425), or equivalent
- IBM Open Systems Adapter-2 (OSA-2) (supported OSA-2 features are server-dependent)
- IBM Open Systems Adapter-Express (OSA-Express) (supported OSA-Express features are server-dependent)
- IBM Open Systems Adapter-Express2 (OSA-Express2) (supported OSA-Express2 features are server-dependent)
- 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 z/VM or to z/OS using the IBM 3088.

- IBM ESCON Channel-to-Channel Adapter

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

- IBM FICON® Channel-to-Channel Adapter

Technical information

TCP/IP for z/VM supports direct connection to another TCP/IP for z/VM or to z/OS using the IBM FICON Channel-to-Channel Adapter.

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

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

VM Guest RSA-Assist Support for Linux hardware requirements

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

- IBM Crypto Express2 (CEX2) configured as a coprocessor (CEX2C) or accelerator (CEX2A)
- IBM PCIX Cryptographic Coprocessor (PCIXCC)
- IBM PCI Cryptographic Accelerator (PCICA)
- IBM PCI Cryptographic Coprocessor (PCICC)

Device support

z/VM handles real devices as supported or unsupported.

Supported devices

A supported device is one of those listed in Appendix C, “IBM devices supported by z/VM,” on page 93. The use of such a device is fully supported by IBM through the service support available with z/VM. A supported device can be supported either for CP and guest use or for dedicated use by only a single guest.

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

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

Unsupported devices

In addition to the devices listed in Appendix C, “IBM devices supported by z/VM,” on page 93, you can also connect other devices to z/VM if they are equivalent or similar to any of the supported devices. Such other devices are referred to as unsupported devices, and proper operation of such devices with z/VM and guest operating systems is your responsibility. IBM does not guarantee that unsupported devices run properly with z/VM, and service support for such device attachments is not supplied.

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

If a device is not equivalent to any supported device but is more or less similar to one, you can define it as an unsupported device. An unsupported device must be dedicated to a single guest; that is, an unsupported device cannot be a system or CP-owned device. You define an unsupported device by calling it a device type other than any of those shown in Appendix C, “IBM devices supported by z/VM,” on page 93, 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.

Software (program) requirements

This section identifies the additional licensed programs and other program materials required by z/VM V5.4. It includes the following topics:

- “Prerequisite licensed programs”
- “High Level Assembler” on page 26
- “Required levels of z/VM base facilities and optional features” on page 26
- “Shared-DASD complex and CSE cluster program requirements” on page 27
- “DFSMS/VM program requirements” on page 27
- “DirMaint program requirements” on page 28
- “HCD and HCM program requirements” on page 28
- “Language Environment program requirements” on page 28
- “OpenExtensions program requirements” on page 29
- “OSA/SF program requirements” on page 29
- “Performance Toolkit program requirements” on page 29
- “RACF program requirements” on page 29
- “RSCS program requirements” on page 29
- “TCP/IP program requirements” on page 30
- “Online books program requirements” on page 30
- “POSIX program requirements” on page 30
- “Linux program requirements” on page 31
- “Program requirements for other IBM products” on page 31

Prerequisite licensed programs

z/VM V5.4 requires the following additional IBM licensed programs:

- Environmental Record Editing and Printing (EREP/VM), V3.5 (5654-260)
The PTFs for the following APARs have been applied to the copy of EREP/VM preinstalled with z/VM:
 - APAR VM63624 provides support for large disk sizes on the DS6000™ and DS8000.
 - APAR VM63743 provides support for the z9™ EC server.
 - APAR VM63946 provides support for the z9 BC server.
 - APAR VM64367 provides support for the z10 EC™ server.
- Device Support Facilities: ICKDSF for VM, V1.17 (5684-042) or later.

Any fixes requested for ICKDSF should specify the PTF number of the VMSES/E formatted update. VMSES/E installable PTFs have the release number G14. 'G' indicates release 17 of ICKDSF and '14' indicates VMSES/E format.

The PTFs for the following APARs have been applied to the copy of ICKDSF preinstalled with z/VM:

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- APAR PQ84848 provides support for large FBA devices.
- APAR PQ95319 provides support for large disk sizes on the DS6000.
- APAR PQ96706 provides support for large disk sizes on the DS8000.

EREP/VM and ICKDSF are preinstalled with z/VM. That is, they are included on the z/VM System Image and 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.

High Level Assembler

Although not a prerequisite for z/VM, the IBM High Level Assembler, V1.5 (5696-234) or later, or an equivalent product, is required for several tasks, such as:

- Creating a new DMSTRT for system languages (NLS)
- Creating image libraries for system printers (FCBs)
- Creating GCS application segments (CONTENTS macro)
- Accessing major CMS application interfaces (CMSCALL)
- Accessing most CP application interfaces (DIAGNOSE)
- Modifying the AVS tuning control module (AGWTUN)
- Using RAS tools (such as MDCHECK, FS2SFSE, AFTCHAIN, PRINTBLK, and PRINTFST)
- 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
- Creating applications that exploit the IEEE Floating Point hardware facility
- Adding devices that cannot be sensed without using SET RDEVICE (that is, by updating HCPRIO ASSEMBLE)
- Performing local modifications to modules written in assembler
- Servicing the CP Loader (HCPLDR)
- Assembling any CP modules
- Assembling exit routines for CP, DirMaint, or RSCS
- Reassembling CP replacement parts for the RACF Security Server for z/VM
- Migrating (converting) a file containing I/O Configuration Program (IOCP) statements into an existing HCD I/O Definition File (IODF)

The PTF for APAR PK58463 is required for the High Level Assembler, V1.5, to support the new instructions provided with the System z10 server.

The High Level Assembler, V1.6, contains the support for the System z10 instruction set and was made available on July 11, 2008. For additional information on the High Level Assembler, V1.6, see the Hardware Announcement dated June 24, 2008.

Required levels of z/VM base facilities and optional features

z/VM V5.4 supports the following base facilities and optional features:

- Base facilities:
 - HCD and HCM for z/VM, function level 540 (preinstalled)
 - Language Environment, level 540 (preinstalled)

- OSA/SF, function level 440 (preinstalled)
- TCP/IP for z/VM, level 540 (preinstalled)
- Optional features:
 - DFSMS/VM, function level 221 (available with the z/VM V5.4 SDO)
 - Directory Maintenance Facility for z/VM, function level 540 (preinstalled disabled)
 - Performance Toolkit for VM, function level 540 (preinstalled disabled)
 - RACF Security Server for z/VM, function level 540 (preinstalled disabled)
 - RSCS Networking for z/VM, function level 540 (preinstalled disabled)

Previous levels of these facilities and features are not supported by z/VM V5.4. Additional PTFs might be required to support some z/VM V5.4 functions, as indicated in this section.

Shared-DASD complex and CSE cluster program requirements

In a shared-DASD complex, a single DirMaint server with a single source directory can manage the object directory on up to 16 z/VM systems, if the DirMaint executable code disks and source directory disk are shared among all the systems. The following is required to support the shared-DASD complex:

- DirMaint, function level 540
 - Within the shared-DASD complex, all z/VM systems must be running the same DirMaint FL540 service level. Therefore, you must be licensed for the DirMaint FL540 feature on any z/VM V5.4 system in the complex.

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

- The same DirMaint requirements as for the shared-DASD complex described above.
- For shared spool and cross-system messaging:
 - VM/Pass-Through Facility, V2.1.1 (5684-100) or later

DFSMS/VM program requirements

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

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

Note: ISPF is not required if you are using only the 3495 Tape Library Dataserver support of DFSMS/VM.
- To use the minidisk management functions:
 - Directory Maintenance Facility for z/VM, function level 540
- If an external security manager is needed for authorizations:
 - RACF Security Server for z/VM, function level 540, or an equivalent product
- To use the Migration Level 2 (ML2) function:
 - Tivoli Storage Manager Extended Edition for z/OS and z/VM, V5.2 (5698-A11), Tivoli Storage Manager for z/OS and z/VM, V5.2 (5698-A13), or Tivoli Storage Manager for VM (5697-TS9)

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Notes:

1. Program numbers 5698-A11 and 5698-A13 were withdrawn from marketing on January 21, 2005, and service support was discontinued on April 30, 2007.
 2. Program number 5697-TS9 was withdrawn from marketing on March 7, 2005, and service support was discontinued on March 31, 2006.
 - Language Environment, function level 540
- To access the 3495 Tape Library Dataserver for servers capable of 3490/3490E tape I/O but incapable of 3495 Tape Library Data Server control:
 - TCP/IP for z/VM, level 540
 - For remote operations:
 - RSCS Networking for z/VM, function level 540
 - 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)
 - Support for more than 10017 cylinders on an emulated 3390 Model 9 on System Storage DASD subsystems requires the PTF for APAR VM63004. Support for very large (near 1 TB) SCSI disks on the DS8000 and DS6000 requires the PTF for APAR VM63664. These PTFs have been applied to the DFSMS/VM optional feature available with the z/VM V5.4 SDO.
 - Support for DFSMS/VM RMS to share tape drive devices using the multiaccess tape feature of the CP ATTACH command requires the PTF for APAR VM63746. For example, this support allows z/VM 3590 install media to be inserted into, and z/VM V5.4 to be installed from, an Automated Tape Library (ATL). This PTF has been applied to the DFSMS/VM optional feature available with the z/VM V5.4 SDO.
 - Support for locating encryption-capable 3592 tape drives in an Enterprise Automated Tape Library requires the PTF for APAR VM64062. The DFSMS/VM support provides tape-encryption capabilities for a z/VSE guest running on z/VM. This PTF has been applied to the DFSMS/VM optional feature available with the z/VM V5.4 SDO.

DirMaint program requirements

Directory Maintenance Facility for z/VM, function level 540, has no additional program requirements.

HCD and HCM program requirements

To migrate (convert) a file containing I/O Configuration Program (IOCP) statements into an existing HCD I/O Definition File (IODF), you need the following licensed program:

- IBM High Level Assembler, V1.5 (5696-234) or later

Language Environment program requirements

Language Environment, level 540, is equivalent to z/OS V1.9 Language Environment.

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

- IBM High Level Assembler, V1.5 (5696-234) or later

OpenExtensions program requirements

To develop OpenExtensions applications, you need:

- One of the following compilers:
 - IBM XL C/C++ for z/VM, V1.2 (5654-A22)
 - IBM C/C++ for z/VM, V1.1 (5654-A22)
 - IBM C for VM/ESA, V3.1 (5654-033)
- Language Environment, level 540

OSA/SF program requirements

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

Access through the OSA/SF GUI requires:

- TCP/IP for z/VM on the host
- TCP/IP on the workstation
- Java 1.4 runtime and help on the workstation

OSA/SF, function level 440, has the following additional program requirements (already applied to OSA/SF preinstalled with z/VM V5.4):

- APAR OA15170 provides support for Layer 2 and for displaying information for OSN features on the z9 EC and z9 BC servers.
- APAR OA23824 provides support for the z10 EC server.

To support an OSA in TCP/IP Passthru mode in a z/VM V5.4 environment, OSA/SF requires TCP/IP for z/VM, level 540. OSA/SF is required in this mode only if access to one of the OSA's ports is being shared by more than one host program or if an ATM OSA-2 is being used as a LAN Emulation Client (LEC).

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

- *eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature*
- *System z10, System z9 and eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*

Performance Toolkit program requirements

To generate Performance Toolkit graphics on the console of a virtual machine, you need the following licensed program:

- IBM Graphical Data Display Manager (GDDM), 5684-007 or 5684-168

RACF program requirements

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

- IBM High Level Assembler, V1.5 (5696-234) or later

RSCS program requirements

RSCS Networking for z/VM, function level 540, has the following additional program requirements:

- Group Control System (GCS) must be configured and activated.
- To communicate with users in an SNA network:

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- VTAM for VM/ESA, V4.2 (5654-010)
- To communicate within an IP network:
 - TCP/IP for z/VM, level 540

TCP/IP program requirements

TCP/IP for z/VM, level 540, has the following additional program requirements:

- The PTF for APAR PK65850 is required to support the CMS-based SSL server.
- If a primary or secondary domain name server is to be run (not a caching-only name server):
 - IBM DB2 Server for VSE & VM, V7.3 (5697-F42), or later
- If an external security manager is needed:
 - RACF Security Server for z/VM, function level 540, or an equivalent product
- To develop programs in C:
 - One of the following compilers:
 - IBM XL C/C++ for z/VM, V1.2 (5654-A22)
 - IBM C/C++ for z/VM, V1.1 (5654-A22)
 - IBM C for VM/ESA, V3.1 (5654-033)
 - Language Environment, level 540
- To develop programs in Pascal:
 - IBM VS Pascal, V1.2 (5668-767), Compiler and Library

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

Online books program requirements

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

PDF books

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

BookManager books

To view BookManager books on z/VM, IBM BookManager READ/VM, Version 1 (5684-062) Release 3 or later, is required. This program might have additional program requirements. See the BookManager announcement documentation.

To run BookManager READ/VM Public Library in non-370 mode, the PTF for BookManager APAR GC05366 is required.

To view and search BookManager files and bookshelves on a Windows workstation, the IBM Softcopy Reader is required. This program is included on the publications CD-ROM and DVD supplied with z/VM.

POSIX program requirements

Developing POSIX applications on z/VM requires one of the following compiler programs:

- IBM XL C/C++ for z/VM, V1.2 (5654-A22)

- IBM C/C++ for z/VM, V1.1 (5654-A22)
- IBM C for VM/ESA, V3.1 (5654-033)

Linux program requirements

Linux on System z is not provided with z/VM. In order to operate Linux as a guest of z/VM, Linux must be obtained from Linux distribution partners.

For specific function and for the most current information on Linux distributions, see www.ibm.com/systems/z/os/linux/dist.html.

Program requirements for other IBM products

Other IBM licensed products might also have additional program requirements to run on z/VM V5.4. See the product documentation and product Web sites. Also see the IBM z/VM and VM-related licensed products and features Web page at www.ibm.com/eserver/zseries/zvm/related/.

Limitations and restrictions

z/VM has the following limitations:

- z/VM operates only on hardware servers that support the IBM 64-bit z/Architecture. See Appendix A, “IBM servers supported by z/VM,” on page 87.
- z/VM supports only ESA/390, Linux-Only, and z/VM LPARs.
- z/VM may run on IFL processors only if, on the IFL processors, z/VM is being used exclusively to run (1) Linux workloads and, (2) if required, z/VM applications in support of those Linux workloads that are currently running.
- z/VM does not support virtual=real (V=R) or virtual=fixed (V=F) guest images.

General restrictions for z/VM virtual machines

z/VM virtual machines have the following general restrictions:

- Dynamically modified channel programs cannot run in a virtual machine unless the channel program modification facility that the DIAGNOSE interface provides can be used to ensure correct operation of such channel programs.
- The CPUID that appears in most EREP records is not the same as the CPUID of the physical processor on which the error occurred (because there is more than one partition per physical processor in LPAR mode).

DirMaint restrictions

The following restrictions apply to DirMaint, function level 540:

- User IDs defined for DirMaint must conform to the CMS file naming convention. Each profile name and user ID must be unique. The names \$DIRCTL\$ and \$DIRGRP\$ are reserved for DirMaint’s use. Names in the form \$DIRxxx\$ should be avoided because they are reserved for possible future use by DirMaint.
- The display of menus requires a 3270-compatible terminal with a minimum of 24 lines and at least an 80 column line length.
- Exits might 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:

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- 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 extraneous 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 extraneous copies during initialization.
- Volume IDs on MDISK directory statements defined for DirMaint must also conform to the CMS file naming convention. DirMaint does not allow the use of &SYSRES for a volume ID. 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.

Performance considerations

System performance depends on the hardware resources allocated to z/VM V5.4 and on the level of activity within each guest. The results of the performance evaluation of z/VM V5.4 is planned to be available on June 29, 2007 in *z/VM Performance Report* at www.ibm.com/eserver/zseries/zvm/perf/reports/zvm/html/.

Additional z/VM performance information is available on the z/VM Web site at www.ibm.com/eserver/zseries/zvm/perf/tips/.

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

Operating systems supported as guests

See Appendix B, "IBM operating systems supported as guests of z/VM," on page 91.

Other programs supported on z/VM

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

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

National language support

The system default language for z/VM is mixed-case American English. However, z/VM national language support allows you to install a language other than American English on your z/VM system. End users can selectively (through commands) receive messages and z/VM HELP information in that language. Any installed language can be set as the system default language. Each session on the

same system can select a language that is different from another session, as long as the language selected has been installed on that system. For example, one user can be using German while another user is using Japanese.

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

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

Table 1. IBM-translated parts of z/VM

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

Packaging and ordering information

To order z/VM V5.4, order the VM System Delivery Offering (SDO), program number 5741-A06. The SDO is the IBM program offering for z/VM which includes a single deliverable containing the z/VM operating system and a group of fully serviced IBM Licensed Program Products.

The z/VM V5.4 SDO package contains:

- z/VM V5.4 System Image and RSU (recommended service upgrade)
- z/VM SDO optional features and licensed products, if ordered

For more information about the SDO, see www.ibm.com/eserver/zseries/zvm/sdo/.

The z/VM V5.4 System Image is available as:

- Multivolume 3390 DASD Dump Restore (DDR) image on 3590 or 3592 tape cartridges
- Binary image on DVD

The z/VM V5.4 System Image contains:

- Prerequisite IBM licensed programs:
 - EREP/VM, V3.5 (5654-260)
 - ICKDSF for VM, V1.17 (5684-042) (includes ICKDSF Standalone release 17)
- z/VM base components and facilities:
 - AVS
 - CP
 - CMS
 - Dump Viewing Facility
 - GCS
 - HCD and HCM for z/VM, function level 540
 - Language Environment, level 540
 - OSA/SF, function level 440

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- REXX/VM
- TCP/IP for z/VM, level 540 (includes source)
- TSAF
- VMSES/E
- SFS and CRR file pools
- DASD Dump Restore (DDR) program
- Translated CP and CMS message repositories
- English and translated z/VM HELP files
- 3800 printer image library object code
- 3800 printer image library source
- z/VM optional features:
 - DirMaint, function level 540
 - Performance Toolkit for VM, function level 540
 - RACF Security Server for z/VM, function level 540
 - RSCS Networking for z/VM, function level 540

Notes:

1. ICKDSF and EREP/VM are not part of the z/VM product. They are separate prerequisite IBM licensed programs that are included in the z/VM System Image for convenience. Before using ICKDSF and EREP/VM you must be already licensed for them, or you must place orders for them to establish licenses.
2. The DirMaint, Performance Toolkit, RACF, and RSCS optional features are included in the z/VM System Image for convenience. They are installed disabled. If you decide to use any of these features, you must place orders for them so that you can enable them.
3. The DFSMS/VM optional feature is not included in the z/VM System Image. If desired, DFSMS/VM must be ordered as a no-cost optional feature of the z/VM SDO.

Object code only and limited source availability

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

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

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

Integrity and security

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

Data integrity for guests

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

System integrity statement for z/VM

System integrity is an important characteristic of z/VM. 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 an external security manager (ESM), such as RACF. Protected resources 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 and 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.

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Customer responsibilities

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

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

DirMaint system integrity

DirMaint uses standard z/VM system facilities to:

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

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

Security, auditability, and control

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

- Each guest and CMS user runs in a unique virtual machine definition which, in combination with hardware features, prohibits one user from accessing another's data in storage (unless specifically allowed through shared segments, communication vehicles such as IUCV and APPC/VM, or ESA/XC data sharing services).
- z/VM, in combination with hardware features, provides protection against channel programs accessing another user's virtual addresses.
- A password facility provides minidisk security to control both read-only and read-write access.
- Both user ID and password checking are provided to minimize unauthorized system access.
- User class restructure provides customers with the ability to control access to commands and DIAGNOSE codes more precisely through customer-defined classes.
- Journaling is supported on z/VM. In addition, the optional RACF feature provides customers with many of these facilities, as well as other security capabilities.
- Directory control statements and system configuration file statements provide controls for certain POSIX-related functions, such as the ability to change another virtual machine's POSIX security values.

- Authorizations for z/VM guest LANs and virtual switches can be handled by the RACF feature, or by any equivalent external security manager that supports this function.
- Working together, z/VM and the RACF feature support the use of passwords longer than eight characters, called password phrases, that may contain mixed-case letters, numbers, blanks, and special characters.
- z/VM supports drive-based data encryption with the IBM System Storage TS1120 Tape Drive. z/VM supports native and guest use of the IBM Encryption Key Manager for encryption of tapes.

Support for cryptographic facilities on IBM servers

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

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

CMS file pool security

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

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

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

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

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

TCP/IP security

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

- Secure Sockets Layer (SSL) support
SSL provides secure (encrypted) communication between a remote client and a TCP/IP application server. Under SSL protocol, the application server is always

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authenticated. To participate in an SSL session, an application server must provide a certificate from a Certifying Authority to prove its identity.

- Exits to an ESM
TCP/IP servers can be configured to use RACF Security Server for z/VM or another ESM to:
 - Authenticate and authorize access to resources managed by the server
 - Validate client user IDs and passwords
- LDAP server and client
The Lightweight Directory Access Protocol (LDAP) server and associated client utilities provide user authentication, authorization, and auditing capabilities.

DirMaint security

DirMaint supports the z/VM security strategy:

- Access to user IDs is password controlled. DirMaint maintains user passwords, with customer choice of administration control or user control. DirMaint also supports the use of an ESM for password control.
- Access to minidisks is controlled by either passwords or explicit link authorization, as determined by the minidisk owner. Minidisk passwords are optional for controlling minidisk directory links. DirMaint also supports control of minidisk links by an ESM.
- VM system services are used to identify the originating user ID (and node ID) for all requests, whether local (those originating from within the scope of a single system or a multiple system cluster) or remote (those originating from beyond the local system cluster). By default, all local requests must be authenticated by providing the correct logon password for each DirMaint transaction. Remote requests, other than surrogate requests, never require authentication. Unless prohibited by the system administrator, users may request suspension of authentication for local requests (other than surrogate requests). Surrogate requests (whether local or remote) always require authentication, unless the system administrator specifically allows the requesting user ID to make unauthenticated surrogate requests.
- All DirMaint commands involving the DirMaint service machines (DIRMAINT, DATAMOVE, DIRMSATs) are auditable. A few DirMaint commands (CHECK, DEFAULTS, EXECDROP, GLOBALV, HELP) are completely processed in the user's virtual machine, and are therefore not auditable by DirMaint. They may, however, be auditable by an ESM or some other security program.

All messages generated by the DirMaint service machines are auditable.

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

Security provided by RACF Security Server for z/VM

RACF Security Server for z/VM provides additional comprehensive security capabilities. RACF controls user access to the system, checks authorization for use of system resources, and audits the use of system resources. RACF verifies logon passwords and checks access to minidisks, data in spool files, and RSCS nodes. You can use RACF commands to audit security-relevant events and prevent users from entering the CP DIAL and MSG commands before they log on. The events you can audit include:

- Any CP command or DIAGNOSE code (including privileged commands and DIAGNOSE codes)
- The creation, opening, and deletion of spool files
- The dumping and loading of spool files through SPXTAPE commands

- IUCV CONNECT and SEVER operations and certain VMCF functions
- APPC/VM CONNECT and SEVER operations
- The creation and deletion of logical devices.

Chapter 5. z/VM base product

This section provides an overview of the components and additional facilities included in the z/VM base product:

- “CP”
- “CMS” on page 50
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CP

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

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

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

Virtual machine modes

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

- **ESA** virtual machines process according to ESA/390 architecture (31-bit). ESA virtual machines are also capable of processing according to z/Architecture (64-bit) if switched into that mode by a guest operating system.
- **XA** virtual machines are supported for compatibility and are functionally equivalent to ESA virtual machines. Some CMS applications might require CMS to be running in an XA virtual machine.
- **XC** virtual machines process according to ESA/XC architecture.

Notes:

1. 370-mode (IBM System/370™ architecture) virtual machines are not supported. However, the 370 Accommodation Facility allows many CMS applications written

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

2. All z/VM virtual machines are type V=V (virtual=virtual), which means the virtual machine's guest real storage is paged into and out of host real storage. z/VM no longer supports the V=R (virtual=real) and V=F (virtual=fixed) types of virtual machines, also known as preferred virtual machines, which permanently mapped guest real storage to host real storage.

Architecture compatibility

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

z/Architecture support

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

ESA/XC support

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

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

For more information, see *z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation*.

Cross system extensions

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

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

Guest LANs and virtual switches

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

- Virtual adapters —

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

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

A guest LAN can be bridged through a z/VM virtual Internet Protocol (IP) switch, known as a virtual switch, to an associated real LAN connected by an OSA-Express QDIO adapter. A virtual switch allows connectivity to external LAN segments without requiring a router.

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

Inter-System Facility for Communications

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

VM Dump Tool

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

Note: The Dump Viewing Facility interactively diagnoses virtual machine dumps. See “Dump Viewing Facility” on page 57.

Support for hardware facilities, features, and architectures

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

Notes:

1. Support for hardware depends on hardware level and availability. See Chapter 3, “What is new or changed in z/VM V5.4,” on page 9. For detailed information on hardware capabilities, requirements, and availability, see the appropriate Hardware Announcements.
2. In some cases, the CP support is available only to guests.

Collaborative Memory Management Assist

CP supports the Collaborative Memory Management Assist (CMMA) on System z10 and System z9[®] servers. In conjunction with CMMA exploitation in guest operating systems such as Linux on System z, this support allows the CP host and its guests to communicate attributes for specific 4 KB blocks of guest memory. This exchange

of information allows both host and guest to optimize their use and management of memory. For more information, see *z/VM: Performance*.

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 facilities

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

- Crypto Express2 (CEX2), which can be configured as a coprocessor (CEX2C) or an accelerator (CEX2A)
- PCIX Cryptographic Coprocessor (PCIXCC)
- PCI Cryptographic Coprocessor (PCICC) and Accelerator (PCICA)
- CMOS Cryptographic Coprocessor

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

Dynamic memory upgrade

System z servers provide a dynamic storage-reconfiguration capability to change the amount of main storage available for use in an LPAR while the LPAR is active. z/VM exploits this system architecture for its own use and also virtualizes it for guest use. LPAR customization can assign storage to an LPAR as initial or reserved. The reserved storage in the LPAR is further separated by z/VM into standby and reserved. z/VM can dynamically increase the size of its main storage by bringing designated amounts of standby storage online, and z/VM guests can dynamically increase or decrease their amounts of main storage.

Enterprise Systems Connection Architecture

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

Expanded storage

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

Extended Channel Measurement Data Support

CP supports the Extended Channel Measurement Data Support (ECMDS) provided in System z servers (except the zSeries[®] 900 and 800). The extended I/O-measurement facilities in the server provide an extended I/O-measurement block for each subchannel and an extended measurement word at the completion of each I/O operation.

Extended-TOD-Clock Facility

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

Fibre Channel Protocol

CP supports the Fibre Channel Protocol (FCP) hardware channel, which allows a server to connect to a fibre-channel (FC) fabric. This support allows z/VM system

facilities and guest operating systems to access selected devices on small computer system interface (SCSI) controllers connected to the fabric.

Fibre Connection channels

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

A standard FICON channel can provide up to 120 MBps effective bandwidth, compared with 17 MBps for ESCON. A FICON Express channel can provide up to 170 MBps. A FICON Express2 channel is designed to deliver up to 270 MBps. A FICON Express4 channel (available only on System z10 and System z9 servers) is designed to deliver up to 4 Gbps.

FICON Channel-to-Channel Adapter

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

FlashCopy

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

Guest ASCII console

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

HiperSockets

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

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

On System z10, System z9, and zSeries 990 servers, HiperSockets channels can be defined as spanning channels, which can allow them to be configured as part of multiple logical channel subsystems and to be transparently shared among any subset or all of the configured logical partitions. For example, spanned HiperSockets channels can help enable communication among Linux guests running on z/VM images in different logical partitions, when the z/VM images are using different logical channel subsystems.

IEEE Floating Point

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

Integrated 3270 console

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

Integrated systems management

z/VM integrated systems management support uses the Hardware Management Console (HMC) to help enable administration of z/VM guests without having to establish additional network connections and reducing complex configuration of the system. The HMC will automatically detect z/VM images and provide integrated GUI-based basic management of z/VM guests. The z/VM integrated systems management capability supports the following image management functions: activate, deactivate, and display guest status.

z/VM provides a local management interface to allow basic z/VM systems management functions to be managed from the HMC. The z/VM SCLP system service (*SCLP) receives and transmits HMC events. A proxy server directs requests to the Systems Management API server to perform the desired function and send the results back to the HMC using *SCLP. The VM event system service (*VMEVENT) provides notification about certain events that occur in the VM system, such as some virtual machine status changes. The proxy server receives notification when these events occur and reports them to the HMC through the *SCLP interface.

Logical channel subsystem

System z10, System z9, and zSeries 990 and 890 servers provide a logical channel subsystem (LCSS) structure, which allows the definition of more than one channel subsystem, providing channel-path and subchannel controls for configuring channel-subsystem images. Each channel-subsystem image can be configured with up to 256 channel paths, and each logical partition has access to one channel-subsystem image. z/VM dynamic-I/O configuration allows channel paths, control units, and devices to be dynamically added, changed, and deleted in multiple LCSSs when z/VM is running on a server with the applicable hardware support.

MIDAWs

z/VM supports guest use of Modified Indirect Data Address Words (MIDAWs). This hardware feature available on System z10 and System z9 servers can allow more flexibility and performance in certain channel programs as an alternative to data-chained channel-command words (CCWs). MIDAWs accommodate noncontiguous data areas that cannot be handled by the predecessor indirect-data-address words (IDAWs). z/VM support for guest use of MIDAWs can allow operating systems such as z/OS to use this new aspect of z/Architecture without regard to whether the operating systems are running in a logical partition or a virtual machine. This allows guest operating systems to exercise their code-paths just as they would on the real machine during, for example, preproduction testing of z/OS systems. Likewise, the provision of the function in a virtual machine allows guest operating systems to benefit from the real machine's added-value function just as though the guests were running directly on the machine.

Move-Page Facility

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

N_Port ID virtualization

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

NPIV is exclusive to System z10 and System z9 servers and is applicable to all of the FICON features supported on them. NPIV is supported for CP and guest use.

Open Systems Adapter

CP supports guest use of the Open Systems Adapter (OSA) features on System z servers, which provide connectivity to various types of networks:

- OSA-2
- OSA-Express
- OSA-Express2
- OSA-Express3

CP also supports:

- OSA-Express Integrated Console Controller (OSA-ICC), a function of the OSA-Express 1000BASE-T Ethernet feature that integrates 3270 emulation for console session connections into System z10, System z9, and zSeries 990 and 890 servers
- Open Systems Adapter for the Network Control Program (OSA NCP), a function of the OSA-Express2 Gigabit Ethernet and 1000BASE-T Ethernet features on System z10 and System z9 servers that provides channel connectivity from System z operating systems to the IBM Communication Controller for Linux (CCL) on the server.
- Virtual-switch-controlled link aggregation (IEEE 802.3ad), which allows you to dedicate an OSA port to z/VM when the port is participating in an aggregated group. Link aggregation (trunking) is designed to allow you to combine multiple physical OSA-Express2 and OSA-Express3 ports into a single logical link for increased throughput and for nondisruptive failover in the event that a port becomes unavailable.

z/VM includes the Open Systems Adapter Support Facility (OSA/SF) for customizing an OSA's modes of operation. For more information, see "OSA/SF" on page 59.

Parallel Access Volumes

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

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

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

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

Peer-to-Peer Remote Copy

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

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

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

Queued Direct I/O

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

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

In HiperSockets, the QDIO architecture includes a type of high-performance I/O interruption known as an adapter interruption. On System z10, System z9, and zSeries 990 and 890 servers, adapter interruptions are also used by OSA-Express and FCP channels.

In addition, System z10, System z9, and zSeries 990 and 890 servers can provide a performance assist for the virtualization of adapter interruptions being given to guest operating systems running on z/VM. This hardware performance assist can be used by guests that support QDIO.

System z10, System z9, and zSeries 990 and 890 servers also provide QDIO Enhanced Buffer-State Management (QEBSM) and Host Page-Management Assist

(HPMA), which can allow a cooperating guest operating system to initiate QDIO operations directly to the applicable channel, without interception by z/VM, thereby helping to provide additional performance improvements.

SAN Volume Controller

The IBM System Storage SAN Volume Controller is implemented in the storage network between the hosts and the physical storage, providing a common volume-management “utility” shared by all hosts. z/VM supports the SAN Volume Controller through the generic SCSI device driver of z/VM. z/VM support for the SAN Volume Controller allows CP and guest operating systems that use SCSI devices (such as Linux on System z) to access IBM System Storage disk subsystems, including the DS4000™ series, as well as disk subsystems from other manufacturers supported by the SAN Volume Controller. The SAN Volume Controller can be used to provide SCSI devices as emulated FBA devices for use by CP and guest operating systems. Guests can also use SCSI devices accessed through the SAN Volume Controller by dedicated FCP subchannels.

Specialty processors

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

IBM Integrated Facility for Linux (IFL)

IFL processors provide additional processing capacity for Linux workloads. IFLs can be allocated only in a Linux-Only or z/VM-mode LPAR. z/VM can be run on an IFL processor if it is supporting a Linux workload or Linux guests.

IBM Internal Coupling Facility (ICF)

ICF processors allow multiple LPARs running z/OS to manage data and distribute workload in a Parallel Sysplex clustered system.

IBM System z Application Assist Processor (zAAP)

zAAPs provide an economical Java execution environment under z/OS.

IBM System z10 and System z9 Integrated Information Processor (zIIP)

zIIPs are designed to help improve resource optimization and lower the cost for eligible workloads. z/OS exploits zIIPs to offload software system overhead from standard central processors (CPs). This includes certain DB2 processing, enhancing the role of the mainframe as the data hub of the enterprise.

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

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

- Simulation support

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

zIIPs can be simulated only on System z10 and System z9 servers. zAAPs can be simulated only on System z10, System z9, and zSeries 990 and 890 servers.

- Virtualization support

z/VM can create virtual specialty processors for virtual machines by dispatching the virtual processors on corresponding specialty processors of the same type in

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the real configuration. For example, guest support for zAAPs and zIIPs might help improve your total cost of ownership by allowing available zAAP and zIIP capacity not being used by z/OS LPARs to be allocated to a z/VM LPAR hosting z/OS guests running Java and DB2.

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

CMS

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

- Write, test, and debug application programs for use on CMS or guest systems
- Run application programs developed on CMS or guest systems
- Create and edit data files
- Process jobs in batch mode
- Share data between CMS and guest systems
- Communicate with other system users

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

Shared File System

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

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

A file pool is a collection of minidisks assigned to a single virtual machine called a *file pool server machine*. Because the minidisks in the file pool are shared by many users, using SFS can save DASD space. Certain SFS directories can be placed into VM data spaces, providing an additional DASD savings. Using VM data spaces might 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 “DFSMS/VM” on page 61.

CMS application programming

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

- Systems management API
- ESA/XC support

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

Note: Although IBM VSE/VSAM, V6.1 (5686-081), was withdrawn from marketing on September 30, 2005, CMS DOS/BAM will continue to provide its current level of function in support of DOS simulation and VSE/VSAM.

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

Systems management API

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

The API functions are invoked by a client through a sockets interface. For more information, see *z/VM: Systems Management Application Programming*.

CMS Pipelines

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

CMS application multitasking

CMS application multitasking services provide an execution environment for high-performance applications and servers. With CMS multitasking, an application can divide itself into multiple units of execution and provide the ability for these units, called threads, to run on multiple CPUs simultaneously. The multitasking facilities are available only at the application programming level. The CMS user still runs one application at a time, but these applications can split themselves into multiple execution units, or threads. These multitasking facilities allow applications to harness the power of the underlying multiprocessor complex and to overlap operations to achieve high performance. For more information, see *z/VM: CMS Application Multitasking*.

OpenExtensions

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

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

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

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

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

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

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

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

Program Management Binder for CMS

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

Reusable Server Kernel

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

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

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

Virtual Machine Resource Manager

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

- Manage guest performance

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

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

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

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

XEDIT

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

HELP facility

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

- Tasks
- Commands and subcommands

Base Product

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

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

TCP/IP for z/VM

TCP/IP for z/VM brings the power and resources of your mainframe server to the Internet. Using the TCP/IP protocol suite of TCP/IP for z/VM, you can reach open multivendor networking environments from your z/VM system. TCP/IP for z/VM allows z/VM systems to act as peers of other central computers in TCP/IP open networks. Applications can be shared transparently across z/VM, Linux, and other environments. As shown in Figure 1 on page 55, users can send messages, transfer files, share printers, and access remote resources across a broad range of systems from multiple vendors.

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

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

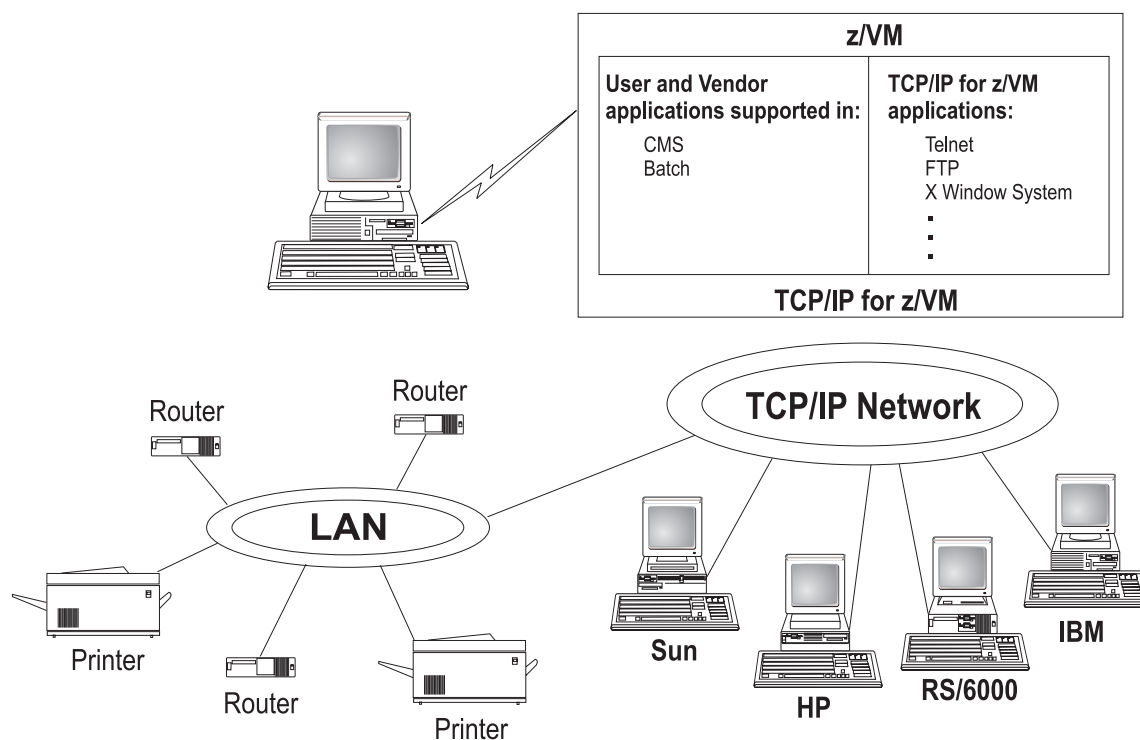


Figure 1. TCP/IP for z/VM as Part of a Multi-Vendor Network

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

Link protocols

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

Network protocols

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

Internet protocol

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

In TCP/IP for z/VM, a single stack provides support for static routing of IP version 6 (IPv6) traffic and IPv4 traffic. IPv6 uses 128-bit addresses. However, the z/VM TCP/IP stack cannot be configured as a tunnel endpoint for tunneling IPv6 traffic over IPv4 networks. Also, the z/VM TCP/IP stack does not support IPv6 security or IPv6 in the upper application layers, such as FTP and SMTP.

Transport protocols

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

Transmission Control Protocol

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

User Datagram Protocol

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

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

Applications and protocols

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

- **Domain Name System (DNS)** is a hierarchical naming system for naming hosts.
- **Dynamic Host Configuration Protocol (DHCP)** provides a framework for passing configuration information to hosts on a TCP/IP network.
- **File Transfer Protocol (FTP)** allows you to transfer data between local and foreign hosts or between two foreign hosts.
- **GDDMXD** is an interface that allows graphics from the IBM Graphical Data Display Manager/VM to be displayed on workstations that support the X Window System.
- **Internet Message Access Protocol (IMAP)** provides the processing that allows a client to access electronic mail that is kept in an IMAP Mailstore server.
- **Kerberos Authentication System** provides additional security by allowing authorization checking at the user level rather than at the node level.
- **Lightweight Directory Access Protocol (LDAP)** provides user authentication, authorization, and auditing capabilities.
- **MPRoute** uses either Open Shortest Path First (OSPF) or Routing Information Protocol (RIP), or both, to dynamically create and maintain network routing tables.
- **Network File System (NFS)** allows you to manipulate files on different TCP/IP hosts as if they reside on your host.
- **Remote Execution Protocol (REXEC)** allows you to execute a command on a foreign host and receive the results on the local host.
- **Remote Printing (LPR and LPD)** provides both client and server support for remote printing.

- **Remote Procedure Call (RPC)** is a programming interface that calls subroutines to be executed on a foreign host.
- **Simple Mail Transfer Protocol (SMTP)** is an electronic mail protocol that is implemented with the CMS NOTE and SENDFILE commands.
- **Simple Network Management Protocol (SNMP)** provides a means for managing an internet environment.
- **Secure Sockets Layer (SSL)** protocol provides privacy between two communicating applications — a client and a server.
- **Socket interfaces** allow you to write your own applications to supplement those supplied by TCP/IP.
- **Telnet Protocol** provides a standard method to interface terminal devices and terminal-oriented processes with each other.
- **X Toolkit** is a collection of basic C language routines for developing a variety of application environments.
- **X Window System** supports network transparent windowing and graphics.

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

AVS

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

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

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

Dump Viewing Facility

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

Note: Analysis of CP standalone dumps, CP ABEND dumps, and virtual machine dumps of a CP system, functions formerly performed by the Dump Viewing Facility, are now performed by the VM Dump Tool. See “VM Dump Tool” on page 43.

GCS

The Group Control System (GCS) runs in an XA or XC virtual machine in place of CMS. It is a virtual machine supervisor, providing multitasking services that allow numerous tasks to remain active in the virtual machine at one time. One of the functions of GCS is to support a native Systems Network Architecture (SNA) network. The SNA network relies on ACF/VTAM, VTAM SNA Console Support

(VSCS), and other network applications to manage its collection of links between terminals, controllers, and processors. GCS provides services for ACF/VTAM, VSCS, and the others, which eliminates your need for VTAM Communications Network Application (VM/VCNA) and a second operating system like VSE. For more information, see *z/VM: Group Control System*.

HCD and HCM for z/VM

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

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

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

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

For more information, see:

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

Language Environment

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

Language Environment consists of:

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

For more information, see:

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

OSA/SF

Open Systems Adapter-Express (OSA-Express), OSA-Express2, and OSA-Express3 are integrated hardware features that allow the System z platform to provide industry-standard connectivity directly to clients on local area networks (LANs) and wide area networks (WANs). The Open Systems Adapter Support Facility (OSA/SF) is a host-based tool supplied with z/VM that allows you to customize an OSA's modes of operation. You can access OSA/SF by a CMS user ID, by a REXX call to the OSA/SF API, or through a Java-based graphical user interface (GUI). For more information, see *System z10, System z9 and eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference*.

REXX/VM

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

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

TSAF

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

VMSES/E

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

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

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

Chapter 6. z/VM optional features

This section provides overviews of the optional features of z/VM:

- “DFSMS/VM”
- “DirMaint”
- “Performance Toolkit for VM” on page 62
- “RACF Security Server for z/VM” on page 63
- “RSCS Networking for z/VM” on page 64

DFSMS/VM

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

- **Space Management**

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

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

- **Minidisk Management**

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

- **Interactive Storage Management Facility (ISMF)**

DFSMS/VM uses the ISMF to provide a consistent user interface for storage management tasks.

- **IBM Tape Library Dataserver Support**

DFSMS/VM provides native z/VM support for the IBM 3494 and 3495 Tape Library Dataservers.

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

DirMaint

Directory Maintenance Facility for z/VM (DirMaint) provides efficient and secure interactive facilities for maintaining your z/VM system directory. Directory management is simplified by DirMaint's command interface and automated facilities. DirMaint provides a corresponding command for every z/VM directory statement, 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.

Optional Features

Program highlights include:

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

For more information, see:

- “DirMaint restrictions” on page 31
- “DirMaint system integrity” on page 36
- “DirMaint security” on page 38
- *z/VM: Directory Maintenance Facility Tailoring and Administration Guide*

Performance Toolkit for VM

The Performance Toolkit for VM, which is derived from the FCON/ESA program (5788-LGA), assists operators and systems programmers or analysts in the following areas:

- Operation of the system operator console in full screen mode
- Support for managing multiple VM systems
- Post processing of VM history files
- Performance monitoring

- Serving data through a web server for viewing with web browsers
- PC-based graphics
- TCP/IP performance reporting

In addition to analyzing VM performance data, the Performance Toolkit processes Linux performance data obtained from the Resource Management Facility (RMF™) Linux performance gatherer, **rmfpms**. The **rmfpms** application is available at www.ibm.com/servers/eserver/zseries/zos/rmf/rmfhtmls/pmweb/pmlin.html.

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

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

RACF Security Server for z/VM

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

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

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

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

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

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

Optional Features

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

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

For more information, see *z/VM: RACF Security Server General User's Guide*.

RSCS Networking for z/VM

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

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

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

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

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

For more information about NJE, see *Network Job Entry: Formats and Protocols*.

RSCS can communicate with station nodes that are:

- ASCII printers or plotters
- Computers running under the control of a system that can provide a multileaving protocol
- IBM 3270 Information Display System Printers
- Line printer router (LPR) daemons and clients in a TCP/IP network

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

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

For more information, see *z/VM: RSCS Networking Planning and Configuration*.

Chapter 7. z/VM library guide

This section provides a guide to the z/VM product information. It contains the following topics:

- “Where to get z/VM information”
- “Abstracts of the z/VM base publications” on page 69
- “Abstracts of the z/VM optional feature publications” on page 82

Where to get z/VM information

The z/VM product information includes primarily z/VM publications, but also includes some z/OS publications and other IBM publications. The z/VM product information is available from several sources, as described in this section.

z/VM V5.4 Information Center

IBM publishes the z/VM V5.4 documentation in an information center using the IBM Eclipse Help System framework. The content of the z/VM V5.4 Information Center (information for the z/VM base and optional features) is identical to that in the traditional IBM BookManager and Adobe PDF formats; however, the presentation might differ to some degree.

Advantages of information centers are:

- Content is indexed by Google and other internet search engines to help locate information more easily.
- Custom searches can be created that include only the information you need for a particular task or job role.

The z/VM V5.4 Information Center is available on:

- An IBM Web site, at publib.boulder.ibm.com/infocenter/zvm/v5r4/index.jsp
- A DVD, which includes the IBM Eclipse Help System framework. The DVD allows you to install the z/VM V5.4 Information Center on a workstation or intranet. The DVD can be ordered (for a fee) from the IBM Publications Center using form number SK5T-7098.

z/VM Internet Library

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

- **z/VM information centers**
- **z/VM LibraryCenters**, which enable you to search the z/VM bookshelf using the following filters to find the location of the primary reference information:
 - Command name
 - Message ID
- z/VM BookManager-format bookshelves (displayed as HTML), offering standard BookManager searching capability
- z/VM PDF libraries
- z/VM program directories
- z/VM data areas, control blocks, and monitor records
- **LookAt**, which provides an online message lookup facility
- IBM Redbooks® publications

Library Guide

- White papers, consultant reports, and performance reports
- Data sheets and brochures
- Reference guides
- Journals, bulletins, and newsletters
- Internet libraries for other IBM licensed programs

z/VM documentation on disk

The z/VM V5.4 Information Center is available on DVD, SK5T-7098.

The z/VM V5.4 Collection (which includes BookManager bookshelves and PDF libraries for z/VM and current IBM licensed programs that run on z/VM) is available on CD-ROM and DVD:

- *IBM Online Library: z/VM Collection*, SK2T-2067
- *IBM Online Library: z/VM Collection on DVD*, SK5T-7054

Notes:

1. Only unlicensed publications are included on the z/VM Collection.
2. Some licensed programs might not have PDF libraries; some publications might not have PDF versions.
3. The CD-ROM is a multi-disk set; the DVD is a single disk.
4. The z/VM Collection also includes the following programs:

IBM Softcopy Reader

Allows you to view and search BookManager files and organize BookManager files 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 or DVD to the workstation or host.

IBM Publications Center

You can obtain z/VM publications from the IBM Publications Center, at www.elink.ibm.com/publications/servlet/pbi.wss. The IBM Publications Center provides worldwide downloading and ordering facilities for a broad range of IBM publications in many languages.

Basic z/VM documentation

The following documentation is shipped automatically with z/VM, at no additional charge:

- One copy of the *IBM Online Library: z/VM Collection on DVD*
- One copy of each of the following z/VM publications:
 - *z/VM: License Information*
 - *z/VM: Guide for Automated Installation and Service*
 - *z/VM: Getting Started with Linux on System z*
- A copy of **one** of the following publications, as appropriate:
 - *z/VM Summary for Automated Installation and Service (DVD Installation)*
 - *z/VM Summary for Automated Installation and Service (Tape Installation)*
- A complete set of z/VM HELP files (included in the z/VM System Image)

Abstracts of the z/VM base publications

The following sections contain abstracts of the publications for the z/VM base product. The publications are grouped in the following topic (task) categories:

- “System overview”
- “Installation, migration, and service”
- “Planning and administration” on page 71
- “Customization and tailoring” on page 73
- “Operation and use” on page 74
- “Application programming” on page 76
- “Diagnosis” on page 80

The suffix of the publication number following the title indicates the edition that supports this z/VM release. Publications that are either new or new editions (compared with what was provided for the previous z/VM release) are indicated. See the publication's Summary of Changes for more information.

Note: For non-z/VM publications:

- The updates in the new edition might not be z/VM related.
- The indicated edition might not be the latest edition; functions described in newer editions might not be supported in this z/VM release.

System overview

These publications provide an overview of z/VM.

z/VM: General Information, GC24-6095-08 (New Edition)

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

- Base product and optional features
- How z/VM can help you
- What is new or changed in the current release
- Hardware and software requirements
- Guide to the z/VM documentation
- IBM servers, guest operating systems, and devices supported by current z/VM releases

z/VM: Glossary, GC24-6097-00

z/VM: Glossary defines the terms used in z/VM publications.

z/VM: License Information, GC24-6102-06 (New Edition)

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

Installation, migration, and service

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

z/VM: Guide for Automated Installation and Service, GC24-6099-05 (New Edition)

z/VM: Guide for Automated Installation and Service contains step-by-step procedures for installing a z/VM system. The procedures feature an automated installation process using a panel interface to load a prebuilt z/VM System Image

packaged in DASD Dump/Restore (DDR) format on magnetic tape or packaged in binary format on DVD. Installation worksheets are included that you can use to plan your installation.

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

Note: Streamlined installation and service procedures are documented in the following publications:

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

z/VM: Migration Guide, GC24-6103-06 (New Edition)

z/VM: Migration Guide provides a history of significant changes and enhancements to VM since VM/ESA V2.1. This information is provided to help system support personnel migrate to the new z/VM release from a previous VM system. It is also intended for application programmers who use VM external interfaces in their programs. This document contains the following information:

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

z/VM: Service Guide, GC24-6117-03 (New Edition)

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

z/VM Summary for Automated Installation and Service (DVD Installation), GA76-0406-02 (New Edition)

z/VM Summary for Automated Installation and Service (DVD Installation) contains streamlined procedures for installing z/VM from DVD and applying service.

z/VM Summary for Automated Installation and Service (Tape Installation), GA76-0407-02 (New Edition)

z/VM Summary for Automated Installation and Service (Tape Installation) contains streamlined procedures for installing z/VM from tape and applying service.

z/VM: VMSES/E Introduction and Reference, GC24-6130-03 (New Edition)

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 *z/VM: Guide for Automated Installation and Service* and *z/VM: Service Guide*. This document 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

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

z/VM: CMS File Pool Planning, Administration, and Operation, SC24-6074-01

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

z/VM: CMS Planning and Administration, SC24-6078-01

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

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

z/VM: Connectivity, SC24-6080-06 (New Edition)

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

z/VM: CP Planning and Administration, SC24-6083-06 (New Edition)

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

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

z/VM: Getting Started with Linux on System z, SC24-6096-03 (New Edition)

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

- z/VM basics
- Planning for Linux virtual servers
- Changing the z/VM system configuration
- Configuring the Directory Maintenance Facility
- Configuring TCP/IP for z/VM
- Creating and cloning Linux virtual machines
- Setting up basic system automation
- Performing runtime tasks
- Monitoring performance and capacity
- Servicing z/VM

z/VM: Group Control System, SC24-6098-03 (New Edition)

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

z/VM: I/O Configuration, SC24-6100-04 (New Edition)

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

z/VM: Running Guest Operating Systems, SC24-6115-03 (New Edition)

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

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

z/VM: Saved Segments Planning and Administration, SC24-6116-02 (New Edition)

z/VM: Saved Segments Planning and Administration describes how to plan for and administer saved segments on your z/VM system. It includes information on the following topics:

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

z/VM: Secure Configuration Guide, SC24-6158-00 (New)

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

z/VM: TCP/IP LDAP Administration Guide, SC24-6140-01 (New Edition)

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

z/VM: TCP/IP Planning and Customization, SC24-6125-04 (New Edition)

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

eServer zSeries 900: Planning for the Open Systems Adapter-2 Feature, GA22-7477-00

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

System z10, System z9 and eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference, SA22-7935-09 (New Edition)

System z10, System z9 and eServer zSeries: Open Systems Adapter-Express Customer's Guide and Reference provides step-by-step instructions for setting up and using the Open Systems Adapter Facility (OSA/SF) to configure and manage OSA-Express features on System z9 and zSeries servers.

System z9 and eServer zSeries 890 and 990: Open Systems Adapter-Express Integrated Console Controller User's Guide, SA22-7990-02

System z9 and eServer zSeries 890 and 990: Open Systems Adapter-Express Integrated Console Controller User's Guide provides instructions for setting up and using the Open Systems Adapter-Express Integrated Console Controller (OSA-ICC), a function of the OSA-Express 1000BASE-T Ethernet feature that integrates 3270 emulation for console session connections into System z9 and zSeries 890 and 990 servers.

z/OS and z/VM: Hardware Configuration Manager User's Guide, SC33-7989-08 (New Edition)

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

Customization and tailoring

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

z/VM: CP Exit Customization, SC24-6082-01

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

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

- Using dynamic CP exits

z/VM: Performance, SC24-6109-05 (New Edition)

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

Operation and use

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

z/VM: CMS Commands and Utilities Reference, SC24-6073-03 (New Edition)

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

z/VM: CMS Pipelines Reference, SC24-6076-02

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

z/VM: CMS Pipelines User's Guide, SC24-6077-01

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

z/VM: CMS Primer, SC24-6137-00

z/VM: CMS Primer provides information on basic CMS tasks and commands. It presents, through examples, only a portion of the functions and commands available with CMS, with the primary emphasis on:

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

z/VM: CMS User's Guide, SC24-6079-01

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

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

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

z/VM: CP Commands and Utilities Reference, SC24-6081-06 (New Edition)

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

z/VM: System Operation, SC24-6121-03 (New Edition)

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

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

z/VM: TCP/IP User's Guide, SC24-6127-04 (New Edition)

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

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

z/VM: Virtual Machine Operation, SC24-6128-02

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

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

z/VM: XEDIT Commands and Macros Reference, SC24-6131-00

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

z/VM: XEDIT User's Guide, SC24-6132-01

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

CMS/TSO Pipelines: Author's Edition, SL26-0018-05

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 document includes reference information on the PIPE command and Pipelines stages, commands, and messages. This document contains additional information not found in *z/VM: CMS Pipelines Reference* and also provides information intended for the advanced Pipelines user.

Application programming

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

z/VM: CMS Application Development Guide, SC24-6069-01

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 document also describes the following CMS services and how you can use them to develop an application:

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

z/VM: CMS Application Development Guide for Assembler, SC24-6070-00

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

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

z/VM: CMS Application Multitasking, SC24-6071-00

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

z/VM: CMS Callable Services Reference, SC24-6072-03 (New Edition)

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

z/VM: CMS Macros and Functions Reference, SC24-6075-00

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

z/VM: CP Programming Services, SC24-6084-05 (New Edition)

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

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

z/VM: CPI Communications User's Guide, SC24-6085-00

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

z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation, SC24-6094-01

z/VM: Enterprise Systems Architecture/Extended Configuration Principles of Operation provides a detailed description of the Enterprise System Architecture/Extended Configuration (ESA/XC) virtual machine architecture. It describes how ESA/XC operates as compared to Enterprise Systems Architecture/390 (ESA/390), upon which ESA/XC is based. It is intended as a reference for programmers who write or debug programs that run in ESA/XC virtual machines.

z/VM: Language Environment User's Guide, SC24-6101-02 (New Edition)

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

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

z/VM: OpenExtensions Advanced Application Programming Tools, SC24-6104-01

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

z/VM: OpenExtensions Callable Services Reference, SC24-6105-01

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

z/VM: OpenExtensions Commands Reference, SC24-6106-02 (New Edition)

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

z/VM: OpenExtensions POSIX Conformance Document, GC24-6107-00

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

z/VM: OpenExtensions User's Guide, SC24-6108-01

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

z/VM: Program Management Binder for CMS, SC24-6110-02 (New Edition)

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

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

z/VM: Reusable Server Kernel Programmer's Guide and Reference, SC24-6112-01

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

z/VM: REXX/VM Reference, SC24-6113-01

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

z/VM: REXX/VM User's Guide, SC24-6114-01

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

z/VM: Systems Management Application Programming, SC24-6122-04 (New Edition)

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

z/VM: TCP/IP Programmer's Reference, SC24-6126-02 (New Edition)

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

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

Common Programming Interface Communications Reference, SC26-4399-09

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, SC31-6821-01

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

z/OS: IBM Tivoli Directory Server Plug-in Reference for z/OS, SA76-0148-00 (New)

z/OS: IBM Tivoli Directory Server Plug-in Reference for z/OS describes the application services routines that can be used to create plug-ins to extend the capabilities of the z/VM TCP/IP LDAP server. For information about creating LDAP server plug-ins on z/VM, see *z/VM: TCP/IP Programmer's Reference*.

z/OS: Language Environment Concepts Guide, SA22-7567-08 (New Edition)

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

z/OS: Language Environment Debugging Guide, GA22-7560-08 (New Edition)

z/OS: Language Environment Debugging Guide provides assistance in detecting and locating programming errors that might occur during run time under Language Environment. The document can help you establish a debugging process to analyze data and narrow the scope and location of where an error might have occurred. You can read about how to prepare a routine for debugging, how to classify errors, and how to use the debugging facilities that Language Environment provides.

z/OS: Language Environment Programming Guide, SA22-7561-08 (New Edition)

z/OS: Language Environment Programming Guide contains information about linking, running, and using services within Language Environment. It also contains the Language Environment program management model and provides language-specific and operating system-specific information, where applicable.

z/OS: Language Environment Programming Reference, SA22-7562-09 (New Edition)

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

z/OS: Language Environment Run-Time Messages, SA22-7566-08 (New Edition)

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

z/OS: Language Environment Writing ILC Applications, SA22-7563-05

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

z/OS MVS Program Management: Advanced Facilities, SA22-7644-07 (New Edition)

z/OS MVS Program Management: Advanced Facilities contains the programming interfaces provided by the program management component of z/OS. It describes the binder application programming interface, macros, user exits, and buffer formats.

z/OS MVS Program Management: User's Guide and Reference, SA22-7643-06 (New Edition)

z/OS MVS Program Management: User's Guide and Reference describes the end user interfaces provided by the program management component of z/OS.

Diagnosis

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

z/VM: CMS and REXX/VM Messages and Codes, GC24-6118-03 (New Edition)

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

z/VM: CP Messages and Codes, GC24-6119-06 (New Edition)

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

z/VM: Diagnosis Guide, GC24-6092-02

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

z/VM: Dump Viewing Facility, GC24-6093-02 (New Edition)

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: Other Components Messages and Codes, GC24-6120-03 (New Edition)

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

Note: Messages issued by the Language Environment component of z/VM are documented in *z/OS: Language Environment Run-Time Messages*.

z/VM: TCP/IP Diagnosis Guide, GC24-6123-03 (New Edition)

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

z/VM: TCP/IP Messages and Codes, GC24-6124-03 (New Edition)

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

z/VM: VM Dump Tool, GC24-6129-03 (New Edition)

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

z/OS and z/VM: Hardware Configuration Definition Messages, SC33-7986-08 (New Edition)

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

Abstracts of the z/VM optional feature publications

The following sections contain abstracts of the publications for the z/VM optional features.

- “DFSMS/VM”
- “Directory Maintenance Facility for z/VM” on page 83
- “Performance Toolkit for VM” on page 83
- “RACF Security Server for z/VM” on page 83
- “RSCS Networking for z/VM” on page 85

The suffix of the publication number following the title indicates the edition that supports this z/VM release. Publications that are either new or new editions (compared with what was provided for the previous z/VM release) are indicated. See the publication's Summary of Changes for more information.

DFSMS/VM

z/VM: DFSMS/VM Customization, SC24-6086-03 (New Edition)

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

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

z/VM: DFSMS/VM Diagnosis Guide, GC24-6087-00

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

z/VM: DFSMS/VM Messages and Codes, GC24-6088-00

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

z/VM: DFSMS/VM Planning Guide, SC24-6089-01

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

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

z/VM: DFSMS/VM Removable Media Services, SC24-6090-03 (New Edition)

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

z/VM: DFSMS/VM Storage Administration, SC24-6091-02

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

Directory Maintenance Facility for z/VM**z/VM: Directory Maintenance Facility Commands Reference, SC24-6133-05 (New Edition)**

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

z/VM: Directory Maintenance Facility Messages, GC24-6134-04 (New Edition)

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

z/VM: Directory Maintenance Facility Tailoring and Administration Guide, SC24-6135-04 (New Edition)

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

Performance Toolkit for VM**z/VM: Performance Toolkit Guide, SC24-6156-02 (New Edition)**

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

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

z/VM: Performance Toolkit Reference, SC24-6157-02 (New Edition)

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

RACF Security Server for z/VM**z/VM: RACF Security Server Auditor's Guide, SC24-6143-00**

z/VM: RACF Security Server Auditor's Guide describes the role of the RACF auditor and explains the auditing tools that RACF provides. Reports on system and

resource use can provide the auditor with information about the basic system-security environment of an installation.

z/VM: RACF Security Server Command Language Reference, SC24-6144-01 (New Edition)

z/VM: RACF Security Server Command Language Reference describes the syntax and functions of RACF commands.

z/VM: RACF Security Server Diagnosis Guide, GC24-6145-01 (New Edition)

z/VM: RACF Security Server Diagnosis Guide explains how to diagnose problems that might occur in RACF.

z/VM: RACF Security Server General User's Guide, SC24-6146-01 (New Edition)

z/VM: RACF Security Server General User's Guide teaches general users how to use RACF to protect their own minidisks, SFS files, SFS directories, and other general resources. It contains an introduction to RACF and sections that guide the user through basic security tasks.

z/VM: RACF Security Server Macros and Interfaces, SC24-6147-01 (New Edition)

z/VM: RACF Security Server Macros and Interfaces describes the syntax and functions of RACF customization macros. It also contains information about other interfaces such as RACF SMF records and subcodes of CP DIAGNOSE code X'A0'. This document does not describe the RACROUTE macro or the independent RACF system macros, which are described in *z/VM: Security Server RACROUTE Macro Reference*.

z/VM: RACF Security Server Messages and Codes, GC24-6148-01 (New Edition)

z/VM: RACF Security Server Messages and Codes describes RACF messages, abend codes, manager return codes, and utility return codes.

z/VM: RACF Security Server Security Administrator's Guide, SC24-6142-01 (New Edition)

z/VM: RACF Security Server Security Administrator's Guide provides information to help the RACF security administrator to:

- Plan how to use RACF, which includes deciding which resources are protected and which users and groups are known to RACF
- Perform daily administration tasks, such as giving users access to the system (assigning user IDs and passwords) and giving users access to system resources or functions
- Coordinate with other administrators, such as the tape librarian

z/VM: RACF Security Server System Programmer's Guide, SC24-6149-01 (New Edition)

z/VM: RACF Security Server System Programmer's Guide provides information for system programmers or installation personnel responsible for:

- Maintaining RACF databases
- Writing, testing, and installing RACF exits
- Modifying RACF to satisfy an installation's particular needs

z/VM: Security Server RACROUTE Macro Reference, SC24-6150-00

z/VM: Security Server RACROUTE Macro Reference describes the full-function RACROUTE external security interface for z/VM, the requests that can be invoked

by it, their respective syntax, and related information. This document is intended for programmers who are writing applications that need to invoke RACF (or another external security manager) from z/VM, or programmers who are writing an external security manager for z/VM.

RSCS Networking for z/VM

z/VM: RSCS Networking Diagnosis, GC24-6151-01 (New Edition)

z/VM: RSCS Networking Diagnosis describes the functions of RSCS and RSCS diagnostic aids and facilities. This document is intended for people who are responsible for isolating and diagnosing any problems that might occur in RSCS operation.

z/VM: RSCS Networking Exit Customization, SC24-6152-01 (New Edition)

z/VM: RSCS Networking Exit Customization describes the RSCS exit facilities. This document describes how you can customize RSCS processing to meet the functional requirements of your facility.

z/VM: RSCS Networking Messages and Codes, GC24-6153-01 (New Edition)

z/VM: RSCS Networking Messages and Codes provides explanations of the messages and abend codes for RSCS and RSCS facilities.

z/VM: RSCS Networking Operation and Use, SC24-6154-01 (New Edition)

z/VM: RSCS Networking Operation and Use explains how to operate RSCS and how to use it to enable your z/VM system to communicate with other systems. This document describes how to send data across the network, how to define and manage links, and how to automate your network. It explains how to operate and use the RSCS server, RSCS domain name server, RSCS dynamic authorization, and the RSCS Data Interchange Manager. This document also describes the syntax and functions of the RSCS commands and link operational parameters and the commands for the other RSCS facilities.

z/VM: RSCS Networking Planning and Configuration, SC24-6155-01 (New Edition)

z/VM: RSCS Networking Planning and Configuration provides a high-level description of RSCS and provides information to help you plan for your RSCS network. This document describes planning tasks for RSCS configuration, operation, administration, and diagnosis. It also describes the syntax and functions of the configuration file statements for the various types of RSCS servers.

Appendix A. IBM servers supported by z/VM

This section provides information about the IBM servers supported by current releases of z/VM. For guest considerations, see Appendix B, “IBM operating systems supported as guests of z/VM,” on page 91.

The following general notes apply to this matrix:

- The Processor Resource/Systems Manager™ (PR/SM™) hardware feature supports the creation of multiple logical partitions (LPARs) on a single central processor complex (CPC), dividing server resources across the LPARs. Each LPAR supports an independent operating system. z/VM supports three LPAR types (modes): ESA/390, Linux-Only, and z/VM (available only on the IBM System z10).
- z/VM supports guest use of IBM mainframe specialty processors:
 - IBM Integrated Facility for Linux (IFL)
 - IBM Internal Coupling Facility (ICF)
 - IBM System z Application Assist Processor (zAAP)
 - IBM System z10 Integrated Information Processor and IBM System z9 Integrated Information Processor (zIIP)
- A Linux-Only LPAR, whether the allocated processors are IFL processors or general purpose processors, will not support any of the IBM traditional operating systems (such as z/OS, z/TPF, or z/VSE). Only Linux on System z or z/VM can run in a Linux-Only LPAR.
- An IFL processor can be defined only in a Linux-Only or z/VM LPAR.
- z/VM may run on IFL processors only if, on the IFL processors, z/VM is being used exclusively to run (1) Linux workloads and, (2) if required, z/VM applications in support of those Linux workloads.
- z/VM can exploit the ESCON Multiple Image Facility (EMIF) when running in an LPAR.
- If an APAR is required for a z/VM release to support a function on a particular server, that APAR might also be required for the same z/VM release to support the same function on a newer server.
- To use the integrated 3270 console task on the Hardware Management Console as a system operator console for z/VM, the server must be running at the current Licensed Internal Code (LIC) level with the Hardware Management Console at V1.8.0 or later.
- Before installing z/VM, refer to the Preventive Service Planning (PSP) bucket for your System z server for the minimum MCL level and any required updates. The PSP buckets can be found on IBM Resource Link™ at www.ibm.com/servers/resourcelink/. A Resource Link user ID and password are required.
- The inclusion of a server in this matrix does not imply that the server is available in all countries.
- For information about IBM servers and z/VM releases not listed in this matrix, see the previous editions of this document.

Server Support

Table 2. Server support

Server	Mode	z/VM Support
System z10 Enterprise Class (z10 EC)	ESA/390	V5.2 (1,2,3,4,5), V5.3 (1,2,3,4,5,6), V5.4
	Linux-Only	V5.2 (1,2,3,4,5), V5.3 (1,2,3,4,5,6), V5.4
	z/VM	(6,7), V5.4
<p>General notes for System z10:</p> <ul style="list-style-type: none"> The configurable Crypto Express2 Accelerator is supported for use by guests. <p>Specific notes for System z10:</p> <p>(1) z/VM V5.2 and V5.3 support for guest exploitation of the System z10 at the level of System z9 functionality requires APARs VM64180 and VM64242.</p> <p>(2) EREP support requires APAR VM64367.</p> <p>(3) CMS IOCP support requires APAR VM64302.</p> <p>(4) HCD/HCM support requires APAR VM64020.</p> <p>(5) OSA/SF support requires APAR OA23824.</p> <p>(6) z/VM V5.3 support for dynamically adding processors to or removing processors from an LPAR in reserve without preplanning requires APARs VM64249, VM64323, and VM64389. Not supported on z/VM V5.2.</p> <p>(7) IPL of z/VM V5.2 or z/VM V5.3 is not supported in a z/VM LPAR. Use ESA/390 or Linux-Only LPARs for z/VM V5.2 and z/VM V5.3.</p>		
System z9 Enterprise Class (z9 EC)	ESA/390	V5.2 (1), V5.3, V5.4
	Linux-Only	V5.2 (1), V5.3, V5.4
System z9 Business Class (z9 BC)	ESA/390	V5.2 (1,2), V5.3, V5.4
	Linux-Only	V5.2 (1,2), V5.3, V5.4
<p>General notes for System z9:</p> <ul style="list-style-type: none"> The configurable Crypto Express2 Accelerator is supported for use by guests. <p>Specific notes for System z9:</p> <p>(1) Support for selected instructions of the z9 EC and z9 BC, GVRP, IPv6 HiperSockets, and enhanced NPIV requires APAR VM63952. This APAR also includes CMS IOCP support for the z9 BC, HCD/HCM support for the z9 BC, and OSA/SF support for Layer 2.</p> <p>(2) EREP support for the z9 BC requires APAR VM63946.</p>		
zSeries 990 (z990)	ESA/390	V5.2, V5.3, V5.4
	Linux-Only	V5.2, V5.3, V5.4
zSeries 890 (z890)	ESA/390	V5.2, V5.3, V5.4
	Linux-Only	V5.2, V5.3, V5.4
zSeries 900 (z900)	Basic	V5.2, V5.3, V5.4
	ESA/390	V5.2, V5.3, V5.4
	Linux-Only	V5.2, V5.3, V5.4
zSeries 800 (z800)	Basic	V5.2, V5.3, V5.4
	ESA/390	V5.2, V5.3, V5.4
	Linux-Only	V5.2, V5.3, V5.4
<p>General notes for zSeries:</p> <ul style="list-style-type: none"> Where available, the PCI Cryptographic Accelerator, PCI Cryptographic Coprocessor, PCIX Cryptographic Coprocessor, and Crypto Express2 features are supported for use by guests. The CMOS Cryptographic Processor Feature (CCF) for the z900 and z800 is supported for use by guests, except in a Linux-Only LPAR. 		

Appendix B. IBM operating systems supported as guests of z/VM

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

In general, an operating system is supported as a guest of z/VM only where support has been announced for that operating system to run in basic mode or in an LPAR. For example, if an operating system is not supported to run in a Linux-Only LPAR, that operating system is not supported as a guest of z/VM running in a Linux-Only LPAR.

This section is not intended to completely cover the complex issues involved in hardware support. For server considerations, see Appendix A, “IBM servers supported by z/VM,” on page 87.

Running z/VM in an LPAR offers production-level performance for workloads, including a mix of CMS and full-function operating systems. An operating system running as a guest of a z/VM image running in an LPAR will experience performance comparable to running as a guest of a z/VM system running in basic mode on the server. Several hardware assists available to z/VM running in basic mode are not available to z/VM in an LPAR.

Running z/VM in a virtual machine (that is, z/VM as a guest of z/VM, also known as “second-level” z/VM) is functionally supported but is intended only for testing purposes for the second-level z/VM system and its guests (called “third-level” guests). Performance of the third-level guests will not compare favorably to what would be achieved running those guest workloads second-level. The performance expectations should be lowered further if this z/VM configuration is running in an LPAR rather than in basic mode.

The following general notes apply to the matrix:

- All listed guests are supported in ESA virtual machines. XA virtual machines are supported for compatibility and are functionally equivalent to ESA virtual machines.
- Guests may be uniprocessor or multiprocessor.
- For information about product releases not listed, see the previous editions of this document.

Table 3. Guest support

Guest	Host	Support Notes
Linux on System z	z/VM V5.2 z/VM V5.3 z/VM V5.4	
z/OS V1.8 or later (1)	z/VM V5.2 z/VM V5.3 z/VM V5.4	(2) (2) (2)
Notes for z/OS:		
(1)	Exploitation of hardware function by z/OS might require specific levels of z/VM. For details, see <i>z/OS: Planning for Installation</i> , GA22-7504.	
(2)	z/VM does not support external coupling facilities or real coupling links.	

Guest Support

Table 3. Guest support (continued)

Guest	Host	Support Notes
z/OS.e V1.8 (1,2)	z/VM V5.2 z/VM V5.3 z/VM V5.4	(3,4) (3,4) (3,4)
Notes for z/OS.e:		
(1)	z/OS.e V1.8 was the last release of z/OS.e. It has been replaced with the new zNALC pricing offering available with z/OS.	
(2)	Exploitation of hardware function by z/OS.e might require specific levels of z/VM. For details, see <i>z/OS and z/OS.e: Planning for Installation</i> , GA22-7504-16.	
(3)	The z/VM host must be running on a z9 BC, z890, or z800 server.	
(4)	z/VM does not support external coupling facilities or real coupling links.	
z/TPF V1.1 (1)	z/VM V5.2 z/VM V5.3 z/VM V5.4	
Notes for z/TPF:		
(1)	z/TPF is supported as a guest of z/VM in environments where TPF-specific server and DASD control unit RPQs are not required. If in a V=V virtual machine, use of the Emulation Program for 37xx communication controllers is not supported.	
TPF V4.1 (1)	z/VM V5.2 z/VM V5.3 z/VM V5.4	
Notes for TPF:		
(1)	TPF is supported as a guest of z/VM in environments where TPF-specific server and DASD control unit RPQs are not required. If in a V=V virtual machine, use of the Emulation Program for 37xx communication controllers is not supported.	
z/VSE V4.1	z/VM V5.2 z/VM V5.3 z/VM V5.4	
z/VSE V3.1 (1)	z/VM V5.2 z/VM V5.3 z/VM V5.4	
Notes for z/VSE:		
(1)	z/VSE V3.1 can execute in 31-bit mode only. It does not implement z/Architecture, and specifically does not implement 64-bit mode capabilities. z/VSE V3.1 is designed to exploit selected features of System z hardware.	
z/VM V5.4	z/VM V5.2 z/VM V5.3 z/VM V5.4	(1) (1) (1)
z/VM V5.3	z/VM V5.2 z/VM V5.3 z/VM V5.4	(1) (1) (1)
z/VM V5.2	z/VM V5.2 z/VM V5.3 z/VM V5.4	(1) (1) (1)
Notes for z/VM:		
(1)	z/VM Guest Coupling Simulation will not work in the z/VM guest.	

Appendix C. IBM devices supported by z/VM

This section provides information about the IBM devices supported by current releases of z/VM.

The device support matrix is intended to provide a quick reference for support of various devices on z/VM. You should also check the hardware device support list for your server to be sure the hardware supports a particular device. Other devices not found in the device support matrix might be supported; consult Hardware Announcements and device documentation for this information.

Device support might not be in the base z/VM release, but might have been delivered through the service stream by the PTF for an APAR.

Devices are fully supported by z/VM unless otherwise indicated. z/VM supports devices at any of the following three levels of function:

1. **Full support:** z/VM uses the device itself and makes it available to guests. z/VM will usually manage the device on behalf of all users.
2. **Dedicated to a guest or virtual machine:** z/VM does not use the device itself but enables guests or applications in virtual machines to use the device. There are usually no restrictions on the use of the device by a guest or application, except that the device may not be dedicated to more than one virtual machine at a time.
3. **Dedicated to a guest or virtual machine as an unsupported device:** z/VM does not use the device itself but enables guests or applications in virtual machines to use the device. The guest or application is completely responsible for the management and use of the device. Usage restrictions might apply; the major common usage restriction for this type of support is that the device cannot be used as the guest's IPL device.

The device support matrix might show that support for a device was not provided after a particular z/VM release. The following clarifications on the meaning of the programming support withdrawal might be helpful:

- Where programming support for a *real* device has been withdrawn as of some z/VM release, the corresponding *virtual* device remains supported in the same or later z/VM releases.
- There are some device types which can be defined as, or use many of the device attributes of, the real devices for which programming support is being terminated. z/VM support for these currently supported devices remains unchanged.

Additional device restrictions might apply. There might be exceptions to supported devices and releases depending on your specific configuration. See *z/VM: CP Planning and Administration* for your release and applicable Hardware Announcements.

It is sometimes possible to define a device differently depending on whether the definition is done using the system configuration file or dynamic I/O configuration support. For instance, a 3745 Communications Controller would be defined as a 3705 Communications Controller using the system configuration file but as a 3745 Communications Controller using dynamic I/O configuration. For specific details about the system configuration file, see *z/VM: CP Planning and Administration*. For specific details about dynamic I/O configuration, see *z/VM: I/O Configuration*.

Device support

The following general notes apply to the matrix:

- z/VM does not support 7-track tapes.
- For information about IBM devices and z/VM releases not listed in this matrix, see the previous editions of this document.
- If a z/VM-related problem occurs with an OEM device that is equivalent to a supported IBM device listed in this section, IBM will fix the problem if it can be recreated with the corresponding IBM device. Customers should always contact the OEM manufacturer first about any problem encountered with an OEM device to find out if it is a known OEM problem.

Direct access storage devices (DASD)

Table 4. Device support – DASD

Device	z/VM Support	Support Notes
3390 Model A14, A18, B14, B18, B1C, A24, A28, B24, B28, B2C	V5.2, V5.3, V5.4	Supported in native 3390 mode with VSE/VSAM V6.1. Not supported for installation of z/VM.
3390 Model A34, A38, B34, B38, B3C	V5.2, V5.3, V5.4	Supported in native 3390 mode with VSE/VSAM V6.1. Mixed 3390 models are not supported for installation of z/VM.
3390 Model A94, A98, B94, B98, B9C	V5.2, V5.3, V5.4	Although installation of z/VM to this device is supported, it is not recommended. Intended as a mass-storage device. Should not be used for system data or for data for applications that require high performance DASD. 3380 Track Compatibility Mode is not supported. Minidisks used with VSE/VSAM or CMS are limited to 65,536 tracks (4369 cylinders).
RAMAC® Array DASD: 9391 Model A10 Rack with 9392 Model B13 Drawers	V5.2, V5.3, V5.4	Must be defined as a 3390. Attaches to 3990 Model 3 or Model 6 Storage Control. Supported for installation of z/VM only when emulating a 3390 Model 3.
RAMAC Virtual Array Subsystem: 9393 Model 002, T42, or T82	V5.2, V5.3, V5.4	Emulates a 3990 Model 3 Storage Control with 3390 Model 1, 2, and 3 DASD or 3380 Model J and K DASD. Supported for installation of z/VM only when emulating a 3390 Model 3.
RAMAC Array Subsystem: 9394 Model 001, 002, or 003 Cluster Array Controller with 9395 Model B13 or B23 Drawers	V5.2, V5.3, V5.4	Emulates a 3990 Model 2 Storage Control with 3390 Model 3 DASD or 3380 Model K DASD. Supported for installation of z/VM only when emulating a 3390 Model 3.

Table 4. Device support – DASD (continued)

Device	z/VM Support	Support Notes
TotalStorage Enterprise Storage Server [®] (2105) [ESCON or FICON attached]	V5.2, V5.3, V5.4	<p>z/VM automatically virtualizes the controller mode that a guest supports.</p> <p>Models 750 and 800 supported in 2105 native controller mode. z/VM V5.2 requires APAR VM63952.</p> <p>Supported in emulation mode as a 3990 Model 3 or 6 Storage Control.</p> <p>Supported DASD device types are:</p> <ul style="list-style-type: none"> • 3390 Model 2, 3, and 9 DASD (including large Model 9s known as Model 27 and Model 54) • 3390 Model 2 and 3 DASD in 3380 track compatibility mode <p>Only 3390 Model 3 or 9 is supported for installation of z/VM. Mixed 3390 models are not supported for installation of z/VM.</p> <p>The performance-oriented track level commands are supported for guest use only.</p> <p>Parallel Access Volumes (PAVs) are supported as minidisks for guests that exploit PAV architecture. z/VM V5.2 requires APAR VM63952.</p> <p>DFSMS/VM FL221 support for 3390 Model 9 disks larger than 10017 cylinders requires APAR VM63004.</p> <p>For guest use of FlashCopy, the device must be dedicated to the guest or defined as a fullpack minidisk.</p> <p>PPRC is supported for guest use only. Native use of PPRC requires ICKDSF V1.17.</p> <p>For ICKDSF support information, see the ICKDSF Program Directory.</p>
TotalStorage Enterprise Storage Server (2105) [FCP attached]	V5.2, V5.3, V5.4	<p>For native z/VM use, the ESS volumes appear as 9336-20 DASD.</p> <p>For guest use, the ESS volumes can appear either as 9336-20 DASD or as SCSI LUNs directly accessed through FCP subchannels.</p>

Device support

Table 4. Device support – DASD (continued)

Device	z/VM Support	Support Notes
System Storage DS8000 series (2107) [ESCON or FICON attached]	V5.2, V5.3, V5.4	<p>z/VM automatically virtualizes the controller mode that a guest supports.</p> <p>Supported in 2107 native controller mode. z/VM V5.2 requires APAR VM63952.</p> <p>Supported in emulation mode as a 3990 Model 3 or 6 Storage Control.</p> <p>Supported DASD device types are:</p> <ul style="list-style-type: none"> • 3390 Model 2, 3, and 9 DASD (including large Model 9s known as Model 27 and Model 54) • 3390 Model 2 and 3 DASD in 3380 track compatibility mode <p>Only 3390 Model 3 or 9 is supported for installation of z/VM. Mixed 3390 models are not supported for installation of z/VM.</p> <p>Dynamic volume expansion is supported by z/VM V5.3 or later. z/VM V5.3 requires APARs VM64305 and VM64354.</p> <p>The performance-oriented track level commands are supported for guest use only.</p> <p>Parallel Access Volumes (PAVs) are supported as minidisks for guests that exploit PAV architecture. z/VM V5.2 requires APAR VM63952.</p> <p>On FICON-attached DS8000, z/VM V5.3 or later supports HyperPAV volumes as minidisks for guests that exploit this PAV architecture.</p> <p>(continued)</p>

Table 4. Device support – DASD (continued)

Device	z/VM Support	Support Notes
DS8000 [ESCON or FICON] (continued)		<p>DFSMS/VM FL221 support for 3390 Model 9 disks larger than 10017 cylinders requires APAR VM63004.</p> <p>On z/VM V5.2, DirMaint FL510 support for 3390 Model 9 disks larger than 32760 cylinders requires APAR VM63700.</p> <p>For guest use of FlashCopy, the device must be dedicated to the guest or defined as a fullpack minidisk.</p> <p>PPRC is supported for guest use only. Native use of PPRC requires ICKDSF V1.17.</p> <p>For ICKDSF support information, see the ICKDSF Program Directory.</p>
System Storage DS8000 series (2107) [FCP attached]	V5.2, V5.3, V5.4	<p>For native z/VM use, the DS8000 volumes appear as 9336-20 DASD.</p> <p>For guest use, the DS8000 volumes can appear either as 9336-20 DASD or as SCSI LUNs directly accessed through FCP subchannels.</p> <p>DFSMS/VM FL221 support for SCSI LUNs larger than 381 GB requires APAR VM63664.</p> <p>On z/VM V5.2, DirMaint FL510 support for SCSI LUNs larger than 381 GB requires APAR VM63700.</p>

Device support

Table 4. Device support – DASD (continued)

Device	z/VM Support	Support Notes
System Storage DS6000 series (1750) [FICON attached]	V5.2, V5.3, V5.4	<p>z/VM automatically virtualizes the controller mode that a guest supports.</p> <p>Supported in 1750 native controller mode. z/VM V5.2 requires APAR VM63952.</p> <p>Supported in emulation mode as a 3990 Model 3 or 6 Storage Control.</p> <p>Supported DASD device types are:</p> <ul style="list-style-type: none"> • 3390 Model 2, 3, and 9 DASD (including large Model 9s known as Model 27 and Model 54) • 3390 Model 2 and 3 DASD in 3380 track compatibility mode <p>Only 3390 Model 3 or 9 is supported for installation of z/VM. Mixed 3390 models are not supported for installation of z/VM.</p> <p>The performance-oriented track level commands are supported for guest use only.</p> <p>Parallel Access Volumes (PAVs) are supported as minidisks for guests that exploit PAV architecture. z/VM V5.2 requires APAR VM63952.</p> <p>(continued)</p>
DS6000 [ESCON or FICON] (continued)		<p>DFSMS/VM FL221 support for 3390 Model 9 disks larger than 10017 cylinders requires APAR VM63004.</p> <p>On z/VM V5.2, DirMaint FL510 support for 3390 Model 9 disks larger than 32760 cylinders requires APAR VM63700.</p> <p>For guest use of FlashCopy, the device must be dedicated to the guest or defined as a fullpack minidisk.</p> <p>PPRC is supported for guest use only. Native use of PPRC requires ICKDSF V1.17.</p> <p>For ICKDSF support information, see the ICKDSF Program Directory.</p>

Table 4. Device support – DASD (continued)

Device	z/VM Support	Support Notes
System Storage DS6000 series (1750) [FCP attached]	V5.2, V5.3, V5.4	<p>For native z/VM use, the DS6000 volumes appear as 9336-20 DASD.</p> <p>For guest use, the DS6000 volumes can appear either as 9336-20 DASD or as SCSI LUNs directly accessed through FCP subchannels.</p> <p>DFSMS/VM FL221 support for SCSI LUNs larger than 381 GB requires APAR VM63664.</p> <p>On z/VM V5.2, DirMaint FL510 support for SCSI LUNs larger than 381 GB requires APAR VM63700.</p>

DASD control units and storage controls

Table 5. Device support – DASD control units and storage controls

Device	z/VM Releases Providing Support	Support Notes
3990 Model 1, 2	V5.2, V5.3, V5.4	
3990 Model 3	V5.2, V5.3, V5.4	Concurrent Copy function is supported for guest use only.
3990 Model 6	V5.2, V5.3, V5.4	<p>All functions of former 3990 models supported plus increased cache, System Clock Support, and the Control Unit Initiated Reconfiguration feature (CUIR).</p> <p>Concurrent Copy and Extended Remote Copy functions are supported for guest use only.</p>

Tape units and tape libraries

Table 6. Device support – tape units and tape libraries

Device	z/VM Releases Providing Support	Support Notes
3480 Tape Subsystem	V5.2, V5.3, V5.4	Not supported for installation of z/VM.
3490 Tape Subsystem	V5.2, V5.3, V5.4	Not supported for installation of z/VM.
3490E (Enhanced Capability Model) Tape Subsystem	V5.2, V5.3, V5.4	Not supported for installation of z/VM.
TotalStorage Enterprise Automated Tape Library (3494)	V5.2, V5.3, V5.4	<p>Native support is provided in conjunction with DFSMS/VM.</p> <p>Not supported for installation of z/VM.</p>
TotalStorage Virtual Tape Server (3494 VTS)	V5.2, V5.3, V5.4	<p>Native support is provided in conjunction with DFSMS/VM.</p> <p>Not supported for installation of z/VM.</p> <p>Peer-to-Peer VTS and VTS Import/Export are supported for guests.</p>

Device support

Table 6. Device support – tape units and tape libraries (continued)

Device	z/VM Releases Providing Support	Support Notes
3495 Tape Library Dataserver	V5.2, V5.3, V5.4	Native support is provided in conjunction with DFSMS/VM. Not supported for installation of z/VM.
TotalStorage Enterprise Tape System (3590)	V5.2, V5.3, V5.4	To support the 3590 Model H, DFSMS/VM FL221 requires APAR VM63097.
System Storage TS1120 Tape Drive (3592)	V5.2, V5.3, V5.4	z/VM supports drive-based data encryption with the 3592 Model E05. z/VM V5.2 requires APAR VM64063. z/VM V5.3 or later provides drive-based encryption rekey support with the 3592 Model E05. z/VM V5.3 requires APAR VM64260. DFSMS/VM FL221 requires: <ul style="list-style-type: none"> • APAR VM63353 for basic device support. • APAR VM63460 to support Write Once Read Many (WORM) media.

Tape control units

Table 7. Device support – tape control units

Device	z/VM Releases Providing Support	Support Notes
TotalStorage Enterprise Tape Controller 3590 Model A60	V5.2, V5.3, V5.4	

Printers

Table 8. Device support – printers

Device	z/VM Releases Providing Support	Support Notes
3203 Model 5	V5.2, V5.3, V5.4	
3262	V5.2, V5.3, V5.4	
3268 Model 2, 2C	V5.2, V5.3, V5.4	Must be defined as a 3287.
3287 Model 1, 1C, 2, 2C, 4	V5.2, V5.3, V5.4	
3289 Model 1, 3, 4, 8	V5.2, V5.3, V5.4	
3800 Model 1	V5.2, V5.3, V5.4	
3800 Model 3, 6, 8	V5.2, V5.3, V5.4	Full support in Model 1 compatibility mode or using Advanced Function Printing (AFP) programs.

Table 8. Device support – printers (continued)

Device	z/VM Releases Providing Support	Support Notes
3812	V5.2, V5.3, V5.4	Full support through RSCS V3.2 on z/VM V5.2, or the RSCS feature on z/VM V5.3 or later, using AFP 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	V5.2, V5.3, V5.4	Full support through RSCS V3.2 on z/VM V5.2, or the RSCS feature on z/VM V5.3 or later, using AFP programs; downloading of fonts is not supported. Loading of fonts requires PSF/VM licensed program.
3820	V5.2, V5.3, V5.4	Full support through ACF/VTAM V4.2, using AFP programs.
3825	V5.2, V5.3, V5.4	Full support using AFP programs.
3827	V5.2, V5.3, V5.4	Full support using AFP programs.
3835	V5.2, V5.3, V5.4	Full support using AFP programs.
3900	V5.2, V5.3, V5.4	Must be defined as a 3800.
4245 Model 1	V5.2, V5.3, V5.4	Supported as a 4245 or in 3262 compatibility mode.
4245 Model 12, 20	V5.2, V5.3, V5.4	
4248 Model 1, 2	V5.2, V5.3, V5.4	Supported as a 4248 or in 3211 compatibility mode.
6262 Model 14, 22	V5.2, V5.3, V5.4	Must be defined as a 4248 Model 1.

Card readers and card punches

Table 9. Device support – card readers and card punches

Device	z/VM Releases Providing Support	Support Notes
3505 Model B1, B2	V5.2, V5.3, V5.4	
3525 Model P1, P2, P3	V5.2, V5.3, V5.4	

Terminals, displays, and consoles

Most terminals are supported as a virtual machine console (in 3215 emulation mode or 3270 mode). 3270-family displays can be defined generically (for example, as 3270s) with dynamic computation of screen size based on information returned from the device.

z/VM also supports the integrated 3270 console function of the Hardware Management Console.

Display printers

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

Display control units

Table 10. Device support – display control units

Device	z/VM Releases Providing Support	Support Notes
3174	V5.2, V5.3, V5.4	
3272 Model 2	V5.2, V5.3, V5.4	
3274	V5.2, V5.3, V5.4	
3276 Display/Control Unit	V5.2, V5.3, V5.4	Must be dedicated to a virtual machine as a supported device.

Communications controllers

Table 11. Device support – communications controllers

Device	z/VM Releases Providing Support	Support Notes
3745	V5.2, V5.3, V5.4	Must be dedicated to a virtual machine as a supported device. Must be defined as a 3705, unless you are using dynamic system configuration.

Switches

Table 12. Device support – switches

Device	z/VM Releases Providing Support	Support Notes
2032 FICON Director Model 1	V5.2, V5.3, V5.4	
9032 ESCON Director Model 2	V5.2, V5.3, V5.4	
9032 ESCON Director Model 3	V5.2, V5.3, V5.4	
9032 ESCON Director Model 5	V5.2, V5.3, V5.4	
9033 ESCON Director Model 1	V5.2, V5.3, V5.4	
9033 ESCON Director Model 4	V5.2, V5.3, V5.4	

Note: Control units and I/O devices with parallel channels can be attached to ESCON channels through the ESCON Converter Model 1. (See your IBM representative for a list of parallel devices that the ESCON Converter Model 1 supports.) Conversely, the ESCON Converter Model 2 allows ESCON devices to be attached to servers that have parallel channels.

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

Server adapters and miscellaneous devices

Table 13. Device support – server adapters and miscellaneous devices

Adapter/Device	z/VM Releases Providing Support	Support Notes
Channel-to-Channel Adapter (CTCA)	V5.2, V5.3, V5.4	Must be dedicated to a virtual machine as a supported device.

Table 13. Device support – server adapters and miscellaneous devices (continued)

Adapter/Device	z/VM Releases Providing Support	Support Notes
Crypto Express2	V5.2, V5.3, V5.4	<p>Must be dedicated to a Linux or z/OS guest as a supported device.</p> <p>Configurable Crypto Express2 feature (Coprocessor or Accelerator) supported on System z10 and System z9 servers.</p>
ESCON CTCA	V5.2, V5.3, V5.4	Extended mode operation only.
FICON CTCA	V5.2, V5.3, V5.4	Must be dedicated to a guest as a supported device.
FICON Express2	V5.2, V5.3, V5.4	Must be dedicated to a guest as a supported device.
FICON Express4	V5.2, V5.3, V5.4	Must be dedicated to a guest as a supported device.
HiperSockets	V5.2, V5.3, V5.4	Must be dedicated to a virtual machine as a supported device.
OSA-2	V5.2, V5.3, V5.4	<p>Must be dedicated to a virtual machine as a supported device.</p> <p>OSA-2 is recognized as TYPE=OSA.</p> <p>OSA/SF is required to customize the OSA modes. OSA/SF can be running either in an LPAR in the same system complex or as a z/VM guest. OSA/SF for z/VM can be run as a CMS application.</p>
OSA-Express	V5.2, V5.3, V5.4	<p>Must be dedicated to a virtual machine as a supported device.</p> <p>OSA-Express is recognized as TYPE=OSE for the Fast Ethernet and 155 ATM modes.</p> <p>OSA-Express is recognized as TYPE=OSD for the Gigabit Ethernet mode.</p> <p>OSA-Express is recognized as TYPE=OSC for the 1000BASE-T Ethernet feature with the Integrated Console Controller (ICC) function.</p> <p>OSA/SF is required to customize the OSA-Express modes. OSA/SF can be running either in an LPAR in the same system complex or as a z/VM guest. OSA/SF for z/VM can be run as a CMS application.</p>

Device support

Table 13. Device support – server adapters and miscellaneous devices (continued)

Adapter/Device	z/VM Releases Providing Support	Support Notes
OSA-Express2	V5.2, V5.3, V5.4	<p>Must be dedicated to a virtual machine as a supported device.</p> <p>OSA-Express2 is recognized as TYPE=OSD for the Gigabit Ethernet and 10 Gigabit Ethernet modes. z/VM V5.3 or later supports IEEE 802.3ad link aggregation.</p> <p>OSA-Express2 is recognized as TYPE=OSC for the 1000BASE-T Ethernet feature with the Integrated Console Controller (ICC) function.</p> <p>OSA-Express2 is recognized as TYPE=OSN for the Gigabit Ethernet and 1000BASE-T Ethernet features with the Open Systems Adapter for the Network Control Program (OSA NCP) function on System z10 and System z9 servers. Performance Toolkit support for CHPID type OSN on z/VM V5.2 requires APAR VM63952.</p> <p>When OSA-Express3 10 Gigabit Ethernet Long Reach (LR) becomes available, OSA-Express2 10 GbE LR can no longer be ordered on a System z10.</p> <p>OSA/SF is required to customize the OSA-Express2 modes. OSA/SF can be running either in an LPAR in the same system complex or as a z/VM guest. OSA/SF for z/VM can be run as a CMS application.</p>
OSA-Express3	V5.2, V5.3, V5.4	<p>Must be dedicated to a virtual machine as a supported device.</p> <p>OSA-Express3 is recognized as TYPE=OSD for the 10 Gigabit Ethernet mode. z/VM V5.3 or later supports IEEE 802.3ad link aggregation.</p> <p>OSA/SF is required to customize the OSA-Express3 modes. OSA/SF can be running either in an LPAR in the same system complex or as a z/VM guest. OSA/SF for z/VM can be run as a CMS application.</p>
PCI Cryptographic Accelerator	V5.2, V5.3, V5.4	Must be dedicated to a Linux or z/OS guest as a supported device.
PCI Cryptographic Coprocessor	V5.2, V5.3, V5.4	Must be dedicated to a Linux or z/OS guest as a supported device.
PCIX Cryptographic Coprocessor (Crypto Express)	V5.2, V5.3, V5.4	Must be dedicated to a Linux or z/OS guest as a supported device.
SAN Volume Controller 2145	V5.2, V5.3, V5.4	z/VM V5.2 requires APAR VM64128.

Table 13. Device support – server adapters and miscellaneous devices (continued)

Adapter/Device	z/VM Releases Providing Support	Support Notes
3088	V5.2, V5.3, V5.4	Must be dedicated to a virtual machine as a supported device.
3088 Model 61 PSCA Card (common link access to workstations)	V5.2, V5.3, V5.4	
3172 Model 1, 2, 3	V5.2, V5.3, V5.4	Must be dedicated to a virtual machine as a supported device.
3174 Model 12L, 22L	V5.2, V5.3, V5.4	
3737 Remote Channel-to-Channel Unit Model 2	V5.2, V5.3, V5.4	Must be dedicated to a virtual machine as a supported device. Must be defined as a CTCA.
3890™	V5.2, V5.3, V5.4	Must be dedicated to a guest as a supported device.
4753 Network Security Processor	V5.2, V5.3, V5.4	Must be dedicated to a guest as a supported device.
7171 Device Attachment Control Unit	V5.2, V5.3, V5.4	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.
9034 ESCON Converter Model 1	V5.2, V5.3, V5.4	
9035 ESCON Converter Model 2	V5.2, V5.3, V5.4	

Device support

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version 5 release 4

Publication No. GC24-6095-08

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