File No. S370-34
Order No. GC20-1821-3

Systems

IBM Virtual Machine Facility/370: Operating Systems in a Virtual Machine

Release 6 PLC 17

This publication is for system programmers who plan to use System/360 or System/370 operating systems under the control of VM/370. It is also for VM/370 system programmers who plan to use these operating systems or VM/370 under the control of VM/370. The publication describes those aspects of running operating systems under VM/370 that are common to all systems, and it describes how to use VM/370 functions more efficiently when running operating systems under VM/370. The book also provides system planning and operating considerations when running VM/370, DOS/VS, and OS/VS under VM/370.

Many thoughts expressed in this publication are contributions from VM/370 customers and IBM field personnel. As such, these thoughts may not have been formally tested by IBM, and therefore, may prove more useful for some installations than others.

PREREQUISITE PUBLICATION

IBM Virtual Machine Facility/370: Introduction, Order No. GC20-1800

The recommendations in the VM/370 under VM/370 area and in the DOS/VS and OS/VS areas of this publication are meant to help an installation generate operating systems that run more efficiently under VM/370.

VM/370 users made many of these recommendations, and their suggestions have not been submitted to any formal IBM test. As a result, potential users should evaluate the applicability of the recommendations to their installations before implementation.

Fourth Edition (March 1979)

This edition (GC20-1821-3) together with Technical Newsletters GN25-0495, dated August 1, 1979; GN25-0773, dated March 3, 1980; and GN25-0840, dated April 1, 1981; applies to Release 6 PLC 17 (Program Level Change) of the IBM Virtual Machine Facility/370, and to all subsequent releases unless otherwise indicated in new editions or Technical Newsletters.

Technical changes and additions to text and illustrations are indicated by a vertical bar to the left of the change.

Changes are periodically made to the information contained herein; before using this publication in connection with the operation of IBM systems, consult the IBM System/370 Bibliography, Order No. GC20-0001, for the editions that are applicable and current.

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Preface

This publication is for system programmers who run OS, DOS, DOS/VS, DOS/VSE, OS/VS1, OS/VS2 SVS, OS/VS2 MVS, and VM/370 under the VM/370 control program. It is also for VM/370 system programmers who plan to use these System/360 or System/370 operating systems under the control of VM/370.

Users of the control program (CP) should refer to the IBM Virtual Machine Facility/370: CP Command Reference for General Users, Order No. GC20-1820, and IBM Virtual Machine Facility/370: Operator's Guide, Order No. GC20-1806.

Users of the conversational monitor system (CMS) should refer to the IBM Virtual Machine Facility/370: CMS User's Guide, Order No. GC20-1819.

Users of the remote spooling communications subsystem (RSCS) should refer to the IBM Virtual Machine Facility/370: Remote Spooling Communications Subsystem (RSCS) User's Guide, Order No. GC20-1816.

Users of the interactive problem control system (IPCS) should refer to the IBM Virtual Machine Facility/370: Interactive Problem Control System (IPCS) User's Guide, Order No. GC20-1823.

ORGANIZATION

This publication contains these sections:

- "Section 1. General Considerations" provides both introductory and general usage information. The introductory information briefly describes the features of VM/370 as they apply both to the virtual machine and to the operating system that is running in it. The general usage information discusses those aspects of running operating systems under VM/370 that are common to all systems. It also describes how to use VM/370 functions more efficiently when running operating systems under VM/370.
- "Section 2. VM/370 in a Virtual Machine" explains how to test and update a VM/370 system that is itself operating under VM/370.
- "Section 3. DOS/VS in a Virtual Machine" provides operating information specific to running DOS, DOS/VS, and DOS/VSE in a virtual machine. It contains system planning considerations for generating and using these systems under VM/370, rather than stand-alone.
- "Section 4. OS/VS in a Virtual Machine" provides operating information specific to running OS, OS/VS1, and OS/VS2 in a virtual machine. It contains system planning considerations for generating and using these systems under VM/370, rather than stand-alone.

TERMINOLOGY

In this publication, the following terminology is used:

- 2305 refers to the IBM 2305 Fixed Head Storage, Models 1 and 2.
- 3270 refers to a series of display devices, namely, the IBM 3275, 3276, 3277, and 3278 Display Stations. A specific device type is used only when a distinction is required between device types.
- 3330 refers to the IBM 3330 Disk Storage, Models 1, 2, and 11; the IBM 3333 Disk Storage and Control, Models 1 and 11; and the 3350 Direct Access Storage operating in 3330/3333 Model 1 or 3330/3333 Model 2 compatibility mode.
- 3340 refers to the IBM 3340 Disk Storage; Models A2, B1 and B2; and, the 3344 Direct Access Storage, Model B2.
- 3350 refers to the IBM 3350 Direct Access Storage, Models A2 and B2, in native mode.
- FB-512 refers to the IBM 3310 and 3370 Direct Access Storage Devices.

Any information about display terminal usage also applies to the IBM 3138, 3148, and 3158 Display Consoles when used in display mode, unless otherwise noted.

Any information pertaining to the IBM 3284 or 3286 printer also pertains to the IBM 3287, 3288, and 3289 printers, unless otherwise noted.

Any information pertaining to the IBM 2741 terminal also applies to the IBM 3767 terminal, Model 1, operating as a 2741, unless otherwise specified.

For a glossary of VM/370 terms, refer to IBM Virtual Machine Facility/370: Glossary and Master Index, Order No. GC20-1813.

PREREQUISITE PUBLICATIONS

IBM Virtual Machine Facility/370: Introduction, Order No. GC20-1800

COREQUISITE PUBLICATIONS

The reader must also have a basic knowledge of the operating systems he will be using under VM/370. For the titles and abstracts of the appropriate publications, refer to the latest IBM System/370 Bibliography, Order No. GC20-0001.

IBM Virtual Machine Facility/370:

System Programmer's Guide, Order No. GC20-1807

Planning and System Generation Guide, Order No. GC20-1801

CP Command Reference for General Users, Order No. GC20-1820

CMS User's Guide, Order No. GC20-1819

CMS Command and Macro Reference, Order No. GC20-1818

Operator's Guide, Order No. GC20-1806

Terminal User's Guide, Order No. GC20-1810

ASSOCIATED PUBLICATIONS

IBM Virtual Machine Facility/370: OLTSEP and Error Recording Guide, Order No. GC20-1809

OS/VS, DOS/VSE, VM/370 Environmental Recording Editing and Printing (EREP) Program, Order No. GC28-0772

Virtual Machine Facility/370: Features Supplement, Order No. GC20-1757

SUBMITTING INFORMATION ON RUNNING OPERATING SYSTEMS IN A VIRTUAL MACHINE

You are welcome to submit recommendations and hints about generating and running operating systems in a virtual machine for possible inclusion in this publication. You can write a letter, or use either the Suggestion Input Form or the Reader's Comment Form at the back of this publication. Send your recommendations to:

IBM Corporation
Programming Publications
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Endicott, New York 13760

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When submitting recommendations, please indicate the type of operating system (that is, DOS/VS, VS1) and the release level that is used under VM/370.

GUIDELINES AND PROCEDURES

Suggestions for generating and running operating systems can cover any topic currently in the book or can address areas that you think should be added to this publication. Submit input in whatever manner and format is most convenient, but ensure that it is legible, understandable, and follows these guidelines:

- Do not include changes to object modules since such modules are likely to change over time.
- Do not describe a problem unless you have an appropriate solution, circumvention, or alternative included. Tips on things you have to watch out for, or unusual circumstances that can occur in virtual machine operation are, however, suitable topics.
- If you describe useful EXEC procedures for CMS or other programs, test them out to ensure that they work.

Note: The recommendations in the DOS/VS and OS/VS areas of this publication are meant to help an installation in generating operating systems to run more efficiently under VM/370 and also contain operational considerations or hints when using virtual machines. Many of these recommendations were suggested by VM/370 users and have not been submitted to any formal IBM test. As a result, potential users should evaluate the applicability of the recommendations to their installation before implementation.

Contents

The entries in this Table of Contents are accumulative. They list additions to this publication by the following VM/370 System Control Program Products:

- VM/370 Basic System Extensions, Program Number 5748-XX8
- VM/370 System Extensions, Program Number 5748-XE1

However, the text within the publication is not accumulative; it only relates to the one SCP program product that is installed on your system. Therefore, there may be topics and references in this Table of Contents that are not contained in the body of this publication.

FIGURES

Summary of Amendments
For GC20-1821-3
As Updated by GN25-0840
VM/370 Release 6 PLC 17

MISCELLANEOUS

Changed: Documentation Only

This Technical Newsletter incorporates minor technical and editorial changes.

Summary of Amendments
For GC20-1821-3
As Updated by GN25-0773
VM/370 Release 6 PLC 9

MISCELLANEOUS

Changed: Documentation Only

- Incorporated technical and editorial changes to appropriate sections

Summary of Amendments
For GC20-1821-3
As Updated by GN25-0495
VM/370 Release 6 PLC 4

MISCELLANEOUS

Changed: Documentation Only

- Updated references in "Section 1. General Considerations" to reflect support for Multiple SRF devices, the VMDUMP command, and the 3031AP Extended Control Program Support.
- Incorporated technical and editorial changes to appropriate sections.

Summary of Amendments
For GC20-1821-3
VM/370 Release 6 PLC 1

DIRECTORY UPDATE-IN-PLACE SUPPORT

New: Program and Support

VM/370 introduces a new DIAGNOSE instruction code X'84' which updates statements in a directory entry "in place"; that is, when the directory entry size does not change, it updates the entry without recompiling and replacing the entire VM/370 system directory entry file. This DIAGNOSE code has been added to the summary of diagnose codes in "Section 1. General Considerations."

IBM 3800 PRINTING SUBSYSTEM SUPPORT

New: Program and Support

VM/370 introduces a new DIAGNOSE instruction code X'74'. It has a twofold purpose: (1) to load a specific 3800 named system into a virtual machine, and (2) to save a storage image in a specific 3800 named system. This DIAGNOSE code has been added to the summary of diagnose codes in "Section 1. General Considerations."

IBM 3850 MASS STORAGE SYSTEM SUPPORT

New: Program and Support

VM/370 introduces a new DIAGNOSE instruction code X'78'. It permits communication between a virtual machine and VM/370 for MSS support. This DIAGNOSE code has been added to the summary of diagnose codes in "Section 1. General Considerations."

VM/370 supports user minidisks on mass storage system 3330V volumes. The minidisks appear to the virtual machine to be defined on a permanently mounted IBM 3330-1 disk drive. MSS volumes may also be dedicated and attached to a virtual machine as either 3330V or 3330-1 devices. For more information, refer to the topic "IBM 3850 Mass Storage System Considerations" in "Section 4. OS/VS in a Virtual Machine."

PASSWORD-ON-THE-COMMAND-LINE SUPPRESSION

New: Program and Support

VM/370 supports suppression of passwords entered on the command line for the LOGON, AUTOLOG, and LINK commands. The intent is to force passwords to be masked for security purposes. These commands reflect this support where applicable in this publication.

MISCELLANEOUS

Changed: Documentation Only

This revision entirely reorganizes the contents of this publication. It also incorporates minor, miscellaneous technical and editorial changes to several sections. The reorganization provides information more conveniently for its intended audience: System programmers who run System/360 or System/370 operating systems under the control of VM/370, and VM/370 system programmers who use VM/370 or these operating systems under the control of VM/370.

The publication provides a "General Considerations" section that describes common aspects of running operating systems under VM/370. This section also describes how to use VM/370 functions more efficiently when running operating systems under VM/370. The other sections in this publication cover the system planning and operating considerations when running VM/370, DOS/VS, and OS/VS under VM/370.

General information previously documented in this publication is now in these publications:

- VM/370 Planning and System Generation now contains these directory entry topics: "The System Operator's Virtual Machine (Operator)," "A Virtual Machine to Receive System Dumps (Operatns)," and "Other System Virtual Machines."
- VM/370 CP Command Reference for General Users now contains these topics: "Controlling a Terminal Session," "Controlling Input and Output Functions," "Controlling the Virtual Machine," and "Testing and Debugging of Programs."
- VM/370 System Programmer's Guide now contains these topics: "VM/370 Performance Considerations" and "Appendix: General Information for a Virtual System/370 Machine."

Also, this revision deletes many topics that duplicate existing information.

April 1, 1981

Section 1. General Considerations

The Virtual Machine Facility/370 (VM/370) provides an easy, convenient way to use a single terminal to run other operating systems, such as DOS/VS, OS/VS1, or OS/VS2. With VM/370, system programmers can test a new application program with an operating system, or they can develop and test new operating system releases. They can do this work on any shift, and they can do it isolated from any work that is running concurrently elsewhere in the system. This isolation is done by the use of a virtual machine.

A virtual machine is a functional equivalent of an IBM System/370 computing system. Each virtual machine has the functional equivalent of a real processor, main and auxiliary storage, and I/O devices. Because VM/370 only simulates these functions, this simulated machine is referred to as a "virtual" machine. VM/370 manages the functions of a real IBM System/370 in such a way that virtual machines are available to multiple concurrent users.

Before running any operating system in a virtual machine, an installation should consider:

- How can application programs operate efficiently in a virtual machine?
- How it can reduce a virtual machine's I/O operations?
- Which services are available for performance and communication for both VM/370 and a virtual machine?
- What special considerations are there for multiprogramming operating systems under VM/370, such as DOS/VS or OS/VS?
- What operating system functions and devices does VM/370 support and not support?
- How to generate an operating system under VM/370?
- How can virtual machines access the VM/370 system?

In answering these questions, this publication assumes that readers have a basic understanding of VM/370 concepts and functions as described in the VM/370 Introduction. It also assumes that they have a basic understanding of whatever operating system they are running under VM/370.

What virtual machine resources and operating systems can be used under VM/370?

VIRTUAL MACHINE RESOURCES

Virtual machine resources are either shared among users or allocated to users alternately for a specified time period. The resources to be allocated to any particular virtual machine are specified in the VM/370 directory entries for that virtual machine. The directory entries for all virtual machines make up the VM/370 directory file that is usually

located on the VM/370 system residence volume. When a user obtains access to the VM/370 system, a virtual machine is created based upon that user's directory entry. The user can then load any of the supported operating systems and begin processing.

For a virtual machine to begin processing under VM/370, what functions does VM/370 itself provide?

VM/370 Components

The VM/370 system has four components:

- The control program (CP): CP controls the resources of a computer such that multiple virtual machines or computing systems appear to exist.
- The conversational monitor system (CMS): CMS provides a wide range of conversational and time-sharing facilities. By using CMS, an installation can create and manage files, and compile, test, and execute problem programs.
- The remote spooling communications subsystem (RSCS): RSCS transfers spool files between VM/370 users and remote locations over telecommunication lines.
- The interactive problem control system (IPCS): IPCS provides VM/370 problem analysis and management facilities, including problem report creation, problem tracking, and CP abend dump analysis.

For an overview of these VM/370 concepts, refer to VM/370 Introduction.

VIRTUAL MACHINE OPERATING SYSTEMS

While the control program of VM/370 manages the concurrent execution of the virtual machines, it is also necessary to have an operating system manage the work flow within each virtual machine. Because each virtual machine executes independently of other virtual machines, each one can use the same operating system, a different operating system, or different releases of the same operating system.

The operating systems that can execute in virtual machines are:

Batch or Single-User Interactive	Multiple-Access
DOS	VM/370
DOS/VS	Time Sharing
DOS/VSE	Option of OS
OS/PCP	DOS/VSE with
OS/MFT	VSE/ICCF (5746-
OS/MVT	TS1)
OS/VS1	
OS/VS2 SVS	Conversational
OS/VS2 MVS	CMS
OS-ASP	
RSCS	

CP provides each of these with virtual device support and virtual storage. The operating systems themselves execute as though they are controlling real devices and real storage, but they must not violate any of the restrictions listed in VM/370 Planning and System Generation Guide.

Batch and Single-User Interactive Systems

With the exception of OS/PCP, all the batch or single-user systems are multiprogramming systems. However, when operating in a virtual machine under VM/370, the user has the choice of running either multiple partitions in one virtual machine similar to stand-alone operation or single partitions in multiple virtual machines. When running multiple partitions in one virtual machine, multiprogramming and unit record spooling is done by both the operating system and VM/370. This may decrease the overall efficiency of the virtual machine. When running single partitions in multiple virtual machines, the need for multiple virtual storage spaces places a burden on auxiliary storage. However, using shared systems reduces this burden.

Multiple-Access Systems

Each multiple-access system operates in one virtual machine and supports multiple interactive users. The multiple-access virtual machine must first gain access to VM/370 (by using the LOGON command). Subsequently, interactive users can connect to the multiple-access system (either by using the DIAL command or by using a terminal on a dedicated line). Communication between the two is carried out by using the command language of the multiple-access system.

Conversational Monitor System

The conversational monitor system (CMS) is a VM/370 component that provides a wide range of conversational and time-sharing facilities. Together with the control program of VM/370, it provides a time-sharing system suitable for direct problem solving and program development. By using CMS, a virtual machine user can create, update, and manipulate files. The user can also compile, test, and execute problem programs.

The CMS interactive capabilities are extended to DOS/VS users by using either the CMS/DOS environment or CMS. For OS/VS users, a combination of CMS commands and CMS simulation of OS macro instructions provides similar interactive capabilities.

For information on using the CMS virtual machine, refer to VM/370 CMS User's Guide and VM/370 CMS Command and Macro Reference.

OTHER PROGRAMS AND SYSTEMS

For information about other programs and systems that have been used under VM/370, request information on Installed User Programs (IUPs) and Field Developed Programs (FDPs) from your local IBM branch office. For a list of IUPs, refer to VM/370 Planning and System Generation Guide.

ERROR RECORDING AND ANALYSIS

The operating systems commonly run in virtual machines all use SVC 76 to write error records to the error recording data sets. However, in a virtual machine VM/370 intercepts SVC 76 and records the error on its own error recording cylinders. Therefore, error records from all operating systems reside in this one centralized error recording area. To access the recorded data, use the CMS CPEREP command. For further information about error recording and CPEREP, refer to VM/370 OLTSEP and Error Recording Guide.

UNSUPPORTED DEVICES

Virtual machine users may be able to use I/O devices that VM/370 does not support. An unsupported device is a device type that is not listed in the DEVTYPE operand of the RDEVICE macro instruction. To use an unsupported device, a user must attach or dedicate the device to a virtual machine. A dedicated device is one that is not shared among users, but is used exclusively by one user. However, VM/370 supports these dedicated devices only under these conditions:

- No timing dependencies exist in the device or the program.
- No dynamically modified channel programs exist in the access method, except when OS ISAM or OS/VS TCAM Level 5 are used.
- No special functions need to be provided by VM/370.
- None of the other CP restrictions are violated. (Refer to the VM/370 restrictions list in the VM/370 Planning and System Generation Guide.)
- The device is generated into the VM/370 nucleus (by using the RDEVICE macro instruction with the appropriate CLASS operand).

I/O devices that are part of a virtual machine's configuration require real device equivalents. However, exceptions to this rule are:

- Unit record devices, which VM/370 can simulate by using spooling techniques.
- Virtual 2311 disks which VM/370 can map onto 2314 or 2319 disks. One to two full 2311 units can be mapped onto a 2314 or 2319 disk in this manner.
- When 3350 disks are used in 3330-1 or 3330-11 compatibility mode.

Programming Considerations

New application programs should be designed to operate efficiently in a paging environment. Whenever possible, use VM/370 paging instead of DOS/VS or OS/VS paging. That is, make the DOS/VS partitions and OS/VS regions virtual=real (V=R) and large enough to contain the largest jobs. Eliminate all overlays and, if possible, combine into one larger job any multistep jobs that use temporary DASD storage.

PAGING FACTORS

Installations should be aware that the following factors affect the performance of a virtual machine:

- The frequency of real interruptions that occur
- The frequency and type of privileged instructions executed
- Whether the virtual machine assist or VM/370 extended control-program support hardware is on the machine and enabled by both the system operator and by the user
- The frequency of START I/O (SIO) instructions
- Locality of reference for paging activity within virtual storage

These factors are in addition to those described under the topic "Performance Guidelines" in this section.

REDUCING PAGING ACTIVITY

When a virtual machine refers to virtual storage addresses that are not in real storage, a page fault (and paging activity) occurs. Routines that have widely scattered storage references tend to increase the paging load caused by this virtual machine.

When possible, modules dependent upon each other, as well as the related reference tables, constants, and literals, should be located in the same 4K page. Infrequently used routines, such as those that handle unusual error conditions, should not be placed near main routines. To minimize paging, reentrant coding techniques should be used whenever possible.

ABNORMAL TERMINATIONS IN A VIRTUAL MACHINE

Whenever possible with a virtual storage operating system, use its dumping procedure instead of VM/370's. The CP dump program does not print out second level storage pages (that is, V=V regions or partitions of OS/VS and DOS/VS machines) in the correct sequence. Pages that happen to be stored on the OS/VS or DOS/VS paging disk are not printed at all. Also, several special formatting dump programs are available to help a user trace through DOS/VS and OS/VS control blocks. For more debugging information, refer to the VM/370 System Programmer's Guide.

REDUCING A VIRTUAL MACHINE'S I/O OPERATIONS

The number of SIO instructions executed by a virtual machine may be substantially reduced by:

- Using 4K byte blocking factors for I/O areas
- Preallocating the DASD space for OS or OS/VS work data sets
- Using virtual storage instead of DASD work files for smaller temporary files
- Building temporary files in virtual storage and letting VM/370 page out the data (if needed)
- Omitting virtual printers, punches, and readers from each partition or region in a virtual machine because records for these devices are unblocked
- Using the virtual operating system's spooling subystem (such as POWER/VS or JES) because these spooling subsystems use large I/O areas and long chains of CCWs

VIRTUAL MACHINE OPTIONS

VM/370 provides several optional services to virtual machines. Specify these options either in the OPTION control statement of the VM/370 directory program or, for many options, in the CP SET command.

The BMX Option

The BMX (virtual block multiplexer) option allows an operating system running in a virtual machine to overlap multiple SIO requests on a specified channel path. The selector channel mode is the normal (and default) channel mode for virtual machines. When the BMX option is given control, it applies to all channels in the virtual machine, except to channel 0 and channels that have a channel-to-channel adapter (CTCA). This option can be specified regardless of whether block multiplexer channels are attached to the computer. The CP DEFINE command can redefine the channel mode for a virtual machine.

The ECMODE Option

The ECMODE option allows the virtual machine to use the complete set of virtual System/370 control registers and the dynamic address translation feature of the System/370. Programming simulation and hardware features are combined to allow use of all the available features in the hardware. This option is required both for DOS/VS, OS/VS1, and OS/VS2 virtual machines and when executing VM/370 under VM/370. It is also required when executing the generalized trace facility (GTF) under OS/MVT.

The ISAM Option

The ISAM option allows the virtual machine to execute the self-modifying CCW command sequences generated by the OS ISAM modules in OS PCP, MFT, or MVT. This option is not required for the proper functioning of ISAM in DOS or OS/VS. However, the ISAM option is required under one of these two conditions: (1) if ISAM is run in the virtual=real area of an OS/VS virtual machine, or (2) if VM/VS handshaking is active. This option does not permit other types of self-modifying CCW sequences to function.

Certain ISAM channel programs that execute under OS/PCP, MFT, MVT, or in a V=R region of OS/VS use a self-modifying operation that is not allowed under normal VM/370 processing. With the ISAM option selected, VM/370 can scan the specific ISAM channel program to handle the self-modifying sequence properly.

Only those users with the ISAM option in their VM/370 directory entry or who have issued the CP SET ISAM ON command have their CCW strings checked for self-modifying operation; thus, not all users incur the additional VM/370 overhead. This option is not needed for DOS and OS/VS ISAM when run in a V=V region.

The REALTIMER Option

The REALTIMER option updates a virtual machine interval timer when that virtual machine is in a self-imposed wait state. This option is required for virtual machines running systems that wait for a timer interruption to continue processing.

Specifying the Options

The REALTIMER, ISAM, and ECMODE options increase the amount of VM/370 overhead incurred by the virtual machines using them. Therefore, do not specify them for a virtual machine unless they are required. These options can be specified either in the OPTION statement in the VM/370 directory or by using the CP SET command. If a particular situation requires an option only occasionally, use the CP SET command and not the OPTION statement. In this way, the additional overhead is incurred only while the option is in effect.

For more information about specifying these and the other options in the OPTION control statement, refer to the topic "Creating VM/370 Directory Entries" in this section.

DATA TRANSFER USING VMCF

Virtual machines can communicate and exchange data with other virtual machines by using the virtual machine communication facility (VMCF). VMCF is the interface among communicating virtual machines. To initiate a VMCF function, the operating system in the virtual machine must issue a DIAGNOSE instruction code X'68' and specify a register that contains the address of a VMCF parameter list. This list contains a subfunction code identifying the specific request and other information about that request. For a detailed description of both the DIAGNOSE instruction code X'68' and the VMCF parameter list, refer to VM/370 System Programmer's Guide.

BTAM AUTOPOLL CHANNEL PROGRAMS

If an operating system is executing BTAM channel programs, VM/370 checks each BTAM autcpoll CCW string to see if it has been dynamically changed. It does this each time the string is executed. To bypass this checking, issue the CP command:

```
set autopoll on
```

Whenever the BTAM autopoll CCWs are modified, OS/VS1 Release 6 and DOS/VS Release 34 with the Advanced Functions-DOS/VS Program Product (Program No. 5746-XE2) use the DIAGNOSE instruction code X'28' to notify VM/370.

The combination of the SET AUTOPOLL ON command and the use of the diagnose interface reduces VM/370 overhead and improves the overall performance for that particular user. However, both of these facilities must be active.

If a user has specified SET AUTOPOLL ON and the operating system does not use the diagnose interface, a channel program modification goes undetected. The results are unpredictable.

If a user has specified SET AUTOPOLL OFF and the operating system uses the diagnose interface, the unnecessary checking results in performance degradation.

Note: Set DOS/VS AUTOPOLL on when using VM/VS handshaking.

Special Considerations for Multiprogramming Systems under VM/370

When a multiprogramming operating system such as OS/VS or DOS/VS is run in a virtual machine, its resource-management algorithms interact with those of VM/370 -- especially when the virtual operating system has a page wait or an I/O wait. Multiprogramming operating systems use these two methods to interact with VM/370:

- VM/VS handshaking
- The diagnose interface

This topic discusses these methods and also those aspects of running an operating system under VM/370 that apply only in certain unique situations.

VM/VS HANDSHAKING

VM/VS handshaking permits instructions issued by an operating system in a virtual machine to be processed directly by the processor. It also permits VM/370 to simulate privileged instructions. VM/VS handshaking is available for these operating systems running in virtual machines under VM/370:

- DOS/VS Release 34 with the Advanced Functions-DOS/VS Program Product (5746-XE2)
- DOS/VSE with the VSE/Advanced Functions Program Product (5746-XE8)
- VS1 Release 4 and subsequent releases

Handshaking for DOS/VS

DOS/VS Release 34 with the Advanced Functions-DOS/VS Program Product (5746-XE2) uses handshaking. The use and efficiency of DOS/VS with handshaking is similar to VS1. For further details, refer to the appropriate DOS/VS program product publications.

DOS/VSE with the VSE/Advanced Functions Program Product (5746-XE8) uses VM/VS handshaking (also known as the DOS/VSE-VM/370 linkage facility). The use and efficiency of DOS/VSE with handshaking is similar to VS1. For further details, refer to VSE/Advanced Functions General Information, GC33-6106.

Handshaking for VS1

Although handshaking is a system generation feature for VS1, it is active only when VS1 is under the control of VM/370. It is disabled when that same VS1 operating system is run on a real machine. For details about VM/VS handshaking for VS1, refer to the "OS/VS in a Virtual Machine" section in this publication.

THE DIAGNOSE INTERFACE

The diagnose interface, by use of the DIAGNOSE instruction, permits operating systems running in virtual machines under VM/370 to communicate easily and efficiently with VM/370.

While this topic provides a summary of the diagnose interface functions, details about how to use the DIAGNOSE instruction to request these functions are in the VM/370 System Programmer's Guide.

Diagnose Codes

By inserting DIAGNOSE instructions where appropriate in the operating system's code, the following functions can be requested by a virtual machine:

	Diagnose Code
• Examine the processor's extended identification code.	0
• Examine the contents of real storage.	4
• Invoke a virtual console function (that is, a CP command) from the virtual machine operating system.	8
• Obtain, from CP's pseudo timer: - Today's date (mm/dd/yy) - The time-of-day (hh:mm:ss) - Virtual and total processor time used by the virtual machine	C
• Release pages of virtual storage (but not discontiguous storage)	10
• Manipulate an input spool file in one of the following ways: - Read the next reader, punch, or printer spool data - Select a new file for processing - Repeat the active file n times - Restart the current file at the beginning - Backspace one record - Retrieve the subsequent file descriptor	14
• Perform a standard DASD I/O operation.	18
• Clear the VM/370 I/O error recording area on disk.	1C
• Perform a general I/O operation for tape or disk.	20
• Interrogate CP's device type and features control blocks.	24
• Notify CP that a dynamically modified channel program is to be executed.	28
• Locate the start DASD address of the VM/370 I/O error recording area (LOGREC).	2C
• Read one page of LOGREC data.	30
• Read the VM/370 system dump spool file.	34

- Read the VM/370 system symbol table. 38
- Dynamically update the VM/370 directory. 3C
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- Save the 3704/3705 Communications Controller program in page image format. 50
- Specify that the 3270's PA2 key is to be used for either: 54
  - Simulating an external interruption to a virtual machine, such as VS APL.
  - Clearing the output display of a 3270 screen.
- Display the number of characters, up to the size of the output area, on a display screen in one write operation. 58
- Edit error messages. 5C
- Determine the virtual machine storage size. 60
- Find, load, or purge a named segment. 64
  --or--
  Release discontiguous storage.
- Invoke the virtual machine communication facility. 68
- Load a specific 3800 named system into a virtual machine. 74
  --or--
  Save a storage image in a specific 3800 named system.
- Communicate between a virtual machine and VM/370 for MSS support. 78
- Update fields in an online directory entry without recompiling the directory. 84

PAGE WAITS

If, during its execution, an OS- or DOS-created task or program must wait for a VM/370 service such as a virtual storage page, VM/370 marks the virtual machine nondispatchable even though other partitions or tasks in that virtual machine may be ready and available for processing. Those other tasks in the virtual machine cannot be dispatched by the operating system until the VM/370 page wait is satisfied. Thus, the highest priority program of the virtual machine gets almost all of the processor time allocated to that virtual machine, if it can use the time. Therefore, programs running in the other partitions experience significant degradation.

When multiprogramming systems must be executed in a virtual machine, make the partitions or regions as large as practical and execute all jobs V=R. Also, consider using the VM/370 virtual=real option, reserved page frames, or locked pages. When using the VM/370 virtual=real option, it eliminates paging for one virtual machine, but this may adversely affect the paging performance of other virtual machines. The reserved page frames option tends to keep the most active pages in storage, and the locked pages option locks the specified pages in storage.

Note: If the region size is made too large, certain programs, such as the OS sort/merge program, do not run efficiently.

I/O WAITS

On a real machine, when a task is waiting for an I/O operation to complete, the lower priority tasks are given use of the processor. Under VM/370, the I/O operations of a particular virtual machine are overlapped with the processor execution of that and other virtual machines. Consequently, lower priority tasks created by OS and DOS are given the processor resource less frequently when executing in a virtual machine than when executing in a real machine.

To set the priority of a virtual machine, the VM/370 system operator can issue the CP command SET PRIORITY. A low priority value gives the virtual machine a higher priority, and this priority ensures that VM/370 dispatches the virtual machine for execution more frequently than other virtual machines.

To ensure that the lower priority DOS or OS tasks have a chance to execute, installations can use the favored execution option. This option reduces the effect of a variable system load on the favored virtual machine. It allows an installation to modify the normal VM/370 scheduling algorithms and forces VM/370 to devote more of its processor time to a given virtual machine. The option causes VM/370 to keep the specified virtual machine in the active queue, unless it becomes nonexecutable. To obtain this option for a specific virtual machine, the system operator must issue the CP command SET FAVORED.

To guarantee that a certain amount of processor time is made available to a virtual machine, installations can use the favored execution option with the percentage value specified in the SET FAVORED command.

For more details about these performance options, refer to the VM/370 System Programmer's Guide.

SPOOLING

Most multiprogramming operating systems, such as DOS/VS and OS/VS, have their own spooling subsystems (such as POWER, POWER/VS, HASP, or JES). Because VM/370 also provides its own spooling, double spooling can occur. Thus, should an installation:

- Use only the operating system's spooling subsystem?
- Use only VM/370's spooling?
- Use double spooling?

If an installation has a significant amount of printing or punching to do, it may appear that one of the spooling subsystems should be eliminated. This is not necessarily true. In fact, if the multiprogramming operating system's spooling subsystem blocks its output (as does VS1), the most efficient spooling arrangement is usually to let both VM/370 and VS1 spool.

Spooling Recommendations

If DASD space is not a limiting factor, use double spooling. If possible, generate a stripped-down version of the virtual machine's spooling subsystem, eliminating those functions not used by that virtual machine. Make the I/O buffer sizes as large as possible to cut down on SIO instructions.

If an installation has only enough DASD spooling space for one spooling subsystem and if only one virtual machine generates significant amounts of spooled output, then let that virtual machine do the spooling. However, if many virtual machines spool data and must use a common pool of unit record devices, then an installation should probably let VM/370 do the spooling.

Closing Spool Files

Output spool files are not scheduled for the real printer or punch devices until one of these actions occur:

- The user logs off, or VM/370 forces the user off.
- The user loads an operating system via the CP IPL command.
- The user (either manually or through an EXEC procedure) issues the CP CLOSE command to close the spool file.
- VS1 with handshaking uses the diagnose interface to issue the CP CLOSE command after each job completes.
- The installation modifies the operating system by adding DIAGNOSE instructions to communicate with VM/370 to close the spool files.

Thus, until one of the preceding actions occur, the spool files are not sent to the real printer or punch. To keep spool files from building up excessively on the spooling DASD, the user should close these spool files periodically (such as at the end of each job).

PROCESSOR MODEL AND CHANNEL MODEL DEPENDENICIES

Channel checks (that is, channel data checks, channel control checks, and interface control checks) no longer cause the virtual machine to be reset. Thus, an operating system that now runs in a virtual machine can attempt either to recover from a channel check or to terminate in an orderly manner.

If channel error recovery procedures in an operating system depend on the processor model and channel model, then these two requirements must be met for channel error recovery procedures to function reliably after a channel check:

1. Depending upon the recovery procedures of the specific operating system running in the virtual machine, an installation may have to generate the operating system for the same processor model on which VM/370 is to run.
2. The virtual machine configuration must have each virtual channel correspond to a single type and model of real channel.

The second requirement means that all virtual devices on a virtual channel must correspond to real devices on real channels; the real channels must be identical to each other in type and model. For example: Assume that a virtual machine has a 3330 disk on virtual address 280 and a 3340 disk on virtual address 290 that correspond to similar real devices on real addresses 380 and 590, respectively. Because both virtual devices (280 and 290) are on a single virtual channel (channel 2), the corresponding real devices (380 and 590) must both be on real channels that have an identical channel type and model. By meeting this requirement, when an operating system issues a STIDC (store channel ID) instruction to virtual channel 2, VM/370 can simulate it the same way and return consistent results to the operating system.

Not only should the real channels be identical, but generally speaking, they should be of the same type as the virtual channel. (The virtual channel type is defined either in the OPTION statement in the virtual machine's directory entry or by the class G CP DEFINE CHANNEL command.) Two exceptions to this general rule are:

- When the real channel is a block multiplexer channel, the virtual channel can be a selector channel. In this case, the simulated STIDC instruction returns this information to the operating system: (1) the model number of the block multiplexer channel, and (2) a channel type field indicating that the channel is operating in selector mode.

- When the real channels are selector channels, the virtual channel can be a block multiplexer channel. This specification may improve performance when the virtual channel has devices on several real selector channels. It allows the virtual machine to overlap channel operations on the virtual channel and to take full advantage of the several selector channels. However, when VM/370 simulates the STIDC instruction issued to the virtual block multiplexer channel, it gives the operating system the channel type and model number of a selector channel, not of a block multiplexer channel. While this result is inconsistent with the channel's operation as a block multiplexer, the operating system should not detect, or be affected by, this inconsistency.

For further restrictions about channel model-dependent functions, refer to VM/370 Planning and System Generation Guide.

SPECIFYING VIRTUAL MACHINE CONSOLES

To specify more than one console for a virtual machine, the virtual machine user must tell VM/370 about the existence of these additional consoles. Operating systems may support either:

- Multiple consoles -- where different classes of system messages can be routed to different consoles.

--or--

- Alternate consoles -- where the user can switch to a backup console when the primary console becomes inoperative.

To tell VM/370 about the existence of these consoles, either use directory statements or issue CP commands. The way a user specifies the second console depends upon whether:

- The user always wants to use a specific device at a specific I/O address.

  --or--

- The user wants flexibility in selecting which device or terminal is to be used.

Using Specific Devices as Virtual Consoles

Assumption: An OS/VS virtual machine is to run its 3158 display console at address 01F in display operator console mode. Also, the virtual machine is to operate a local 3270 terminal at address 1B8.

Step 1: Generate OS/VS with at least two consoles: 01F as the primary console, and 009 as the secondary console.

Step 2: Specify the secondary console by using the VM/370 CONSOLE directory statement. Code it:

```
CONSOLE 009 3210
```

Step 3: Specify the OS/VS primary console either by having a DEDICATE statement in the VM/370 directory or by using the CP ATTACH command after logon. Either specification allows OS/VS to use the 3158 console in display operator console mode.

If the DEDICATE statement is used, then code it:

```
DEDICATE 01F 01F
```

If the ATTACH command is used, then, after logon, send a message to the VM/370 operator that requests the following ATTACH command to be issued:

```
msg op attach 01f to userid as 01f
```

Using a Device as a Second Console

To use any locally attached 3270 display terminal as the OS/VS primary console in display operator console mode, either have a SPECIAL statement in the virtual machine's VM/370 directory entry or issue the CP DEFINE command after logon to VM/370.

If the SPECIAL statement is used, it appears as follows:

```
SPECIAL 01F 3270
```

If the SPECIAL statement is not used, assume that a local 3270 line has been enabled by the VM/370 operator. Then, issue the following DEFINE command:

```
define graf 01f 3270
```

In either situation, after a user logs onto VM/370 (by using the device specified in the CONSOLE statement) and loads the OS/VS system into the virtual machine, a user must issue the CP DIAL command at the local 3270 that is to be used in display mode. This action logically connects that 3270 and its real I/O address of 1B8 to the operating system. To drop the dialed connection, a user must issue the CP RESET command.

Note: A remote 3270 cannot be used in this manner because the DIAL command does not support remote 3270 terminals.

If the second console is a remote terminal such as a 2741 or 3767 connected by either a 2702 or a 3704/3705 in 2702 emulation mode, the SPECIAL statement would appear as follows:

```
SPECIAL 01F 2702 IBM
```

The DEFINE command would be:

```
define line as 01f ibm
```

VIRTUAL MACHINE I/O MANAGEMENT

A real disk device and a real or emulated 270x transmission control unit (TCU) can be shared among multiple virtual machines. Virtual disk device sharing is specified in the VM/370 directory entry or by a user command. A specific virtual machine may be assigned read-only or read/write access to a shared disk device. To gain access to the shared virtual device, a user must supply the appropriate password. To ensure device integrity, VM/370 checks each virtual machine I/O operation against the parameters in the virtual machine configuration.

The virtual machine operating system is responsible for the operation of all virtual devices associated with it. These virtual devices may be defined in the VM/370 directory entry of the virtual machine, or they may be attached dynamically to (or detached from) the virtual machine's configuration for the duration of the terminal session.

Virtual devices may be in one of these three states or conditions:

- Dedicated -- when mapped to a fully equivalent real device
- Shared -- when mapped to a minidisk or when specified as a shared virtual disk device
- Spooled -- when VM/370 places the device output on intermediate direct access storage

For example: In a real machine when running under control of the operating system, the problem program requests the system to issue a SIO instruction to a specific device. The operating system normally initiates the I/O operation and handles any device error recovery. In a virtual machine, the operating system performs the same functions, but the device address specified and the storage locations referenced are both virtual. VM/370 has the responsibility for translating the virtual specifications to real.

When I/O interruptions occur, VM/370 reflects them to the virtual machine for its interpretation and processing. When I/O errors occur, VM/370 records the error, but it does not initiate error recovery operations. The operating system must handle error recovery.

When VM/370 initiates I/O operations for its own paging and spooling, the operation is not subject to translation, and VM/370 itself performs the operation.

Dedicated Channels

In most cases, many virtual machines share the I/O devices and control units on a channel both as minidisks and dedicated devices and with VM/370 system functions such as paging and spooling. Because of this sharing, VM/370 has to schedule all the I/O requests to achieve a balance among virtual machines. In addition, VM/370 must reflect the results of the subsequent I/O interruption to the appropriate storage areas of each virtual machine.

By specifying a dedicated channel for a virtual machine (using the class B ATTACH CHANNEL command), the virtual machine has the channel and all the devices for its own exclusive use. For dedicated channels, VM/370 translates the virtual storage locations specified in channel commands to real locations and performs any necessary paging operations. However, VM/370 does not translate a device address because the virtual device addresses on the dedicated channel must match the real device addresses; thus, minidisks cannot be used.

Dedicated devices should be considered as an alternative to dedicated channels because then the only translation done by VM/370 is device address translation. Dedicated devices should be specified on separate channels so that VM/370 can handle them more efficiently for a virtual machine.

Defining Direct Access Storage Devices

Virtual machines can use DASD as either minidisks or dedicated volumes. A real disk volume can be shared by several virtual machine users, each owning a number of contiguous cylinders. This logical subdividing of a real disk volume is called physical pack sharing, and each subdivision of cylinders is called a virtual disk or minidisk. A real disk volume can also be dedicated to a specific virtual machine for its own private use. When using dedicated disk volumes, the virtual machine's operating system must perform all necessary interruption handling, error recovery, and error recording.

By using either the LINK directory control statement or the CP LINK command, a user can share the data on a minidisk or entire disk volume with the owner of the virtual disk. The LINK statement or command allows controlled, concurrent access to the data on the virtual disk. This sharing is called logical data sharing.

If any virtual machine temporarily requires additional direct access space, the user can use the CP DEFINE command to obtain it dynamically from a pool of temporary (T-disk) space. To define a pool of T-disk space, an installation specifies the size of the T-disk pool when allocating disk space with the stand-alone CP format/allocate program.

Before using the T-disk space, the user must first initialize it. For storing DOS, OS, or VSAM files, use the IBCDASDI program to initialize the minidisk and set up the VTOC. For CMS files, issue the CMS FORMAT command. Temporary minidisks are available to the virtual machine for the duration of the current terminal session. The area is returned to VM/370 when one of the following actions occur:

- The system forces the virtual machine off.
- The virtual machine logs off.
- The user issues a CP DETACH command to release the temporary minidisk.

For details about defining, formatting, using, and sharing minidisks, refer to VM/370 Planning and System Generation Guide.

ALTERNATE PATH SUPPORT

VM/370 alternate path supports the two-channel and two-channel switch additional features. In the real hardware configuration, the installation of the two-channel switch permits a real connection from two real channels to a single control unit. Installation of the two-channel switch additional feature allows a connection from four different real channels to a single real control unit. The two-channel switch plus the two-channel switch additional features are often referred to as the "four-channel switch."

VM/370 alsc supports the string switch hardware feature that permits a string of real devices to be physically connected to two real control units. With this facility and the four-channel switches installed, VM/370 allows one to eight paths to a given device, as shown in Figure 1.

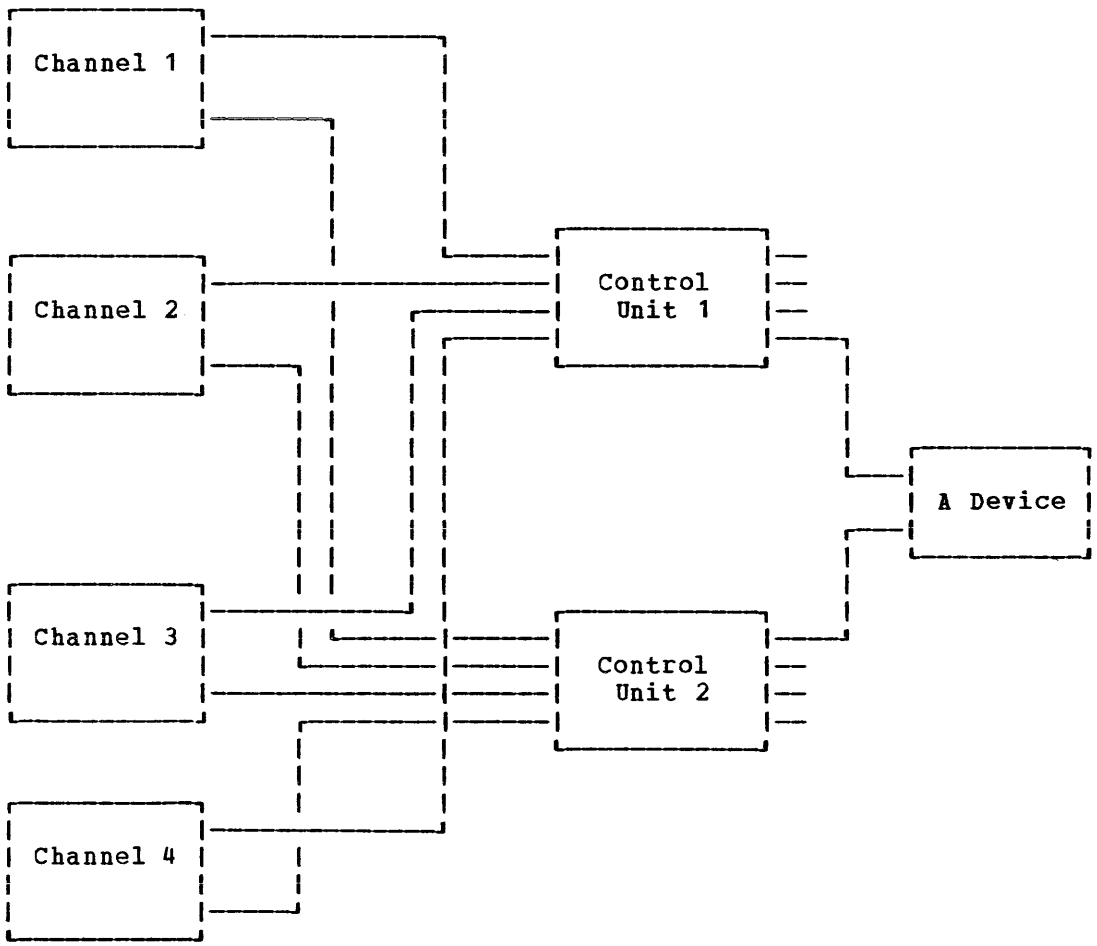


Figure 1. Eight Paths to a Single Device

VM/370 dynamically determines when these hardware features have been installed on a control unit. During VM/370 system generation, VM/370 ignores the operand FEATURE=(2CHANSW) or FEATURE=(4CHANSW) in the RDEVICE macro instruction. However, for compatibility an installation may continue to designate it. For details about the RDEVICE macro instruction, refer to the VM/370 Planning and System Generation Guide.

Note: The alternate path support and the real device reserve/release support must be mutually exclusive of each other. However, alternate path support may be used with virtual device reserve/release support. For details, refer to the topic "Operating Systems Using DASD Reserve/Release" in this section.

When an I/O request is received for a device, VM/370 selects an available path from any of the paths to a device. When the primary path to a device is busy and an alternate path is available, the I/O operation is initiated immediately without being queued. When all paths are busy, the I/O request is queued for all of the paths to that device. The I/O request is then initiated on the first path to become available.

For specific information on channel switching, refer to the VM/370 Planning and System Generation Guide.

OPERATING SYSTEMS USING DASD RESERVE/RELEASE

Reserve/release CCW commands prevent several users of the same data files from simultaneously accessing the same data. It is most useful when that data is being updated. While VM/370 handles the reserve/release CCW commands presented by other operating systems running in virtual machines, VM/370 itself does not use reserve/release CCW commands. Operating systems use these commands under two conditions:

- When running in virtual machines under VM/370 and sharing data files
- When running on other processors and sharing data files with operating systems that run under VM/370

VM/370 has two types of reserve/release support:

- Real -- applies to virtual machines issuing reserve/release CCW commands to a dedicated or attached volume.
- Virtual -- applies to virtual machines issuing reserve/release CCW commands to specially designated minidisks.

Real Reserve/Release Support

Real reserve/release support allows several operating systems, such as MVS, SVS, and VS1, whether running as virtual machines under VM/370 or on other processors to have data protection on a full volume. The device is reserved by the hardware when a reserve CCW command is executed. VM/370 supports reserve/release CCW commands for shared DASD as though each virtual machine has a separate channel path to a shared device.

Note: When a reserve is issued to a device that has alternate path support (defined in the RDEVICE and RCTLUNIT VM/370 system generation macro instructions), VM/370 changes a reserve CCW command to a sense CCW command.

Virtual Reserve/Release Support

Virtual reserve/release support allows several operating systems, such as MVS, SVS, and VS1, to all run as virtual machines under the same VM/370 operating system and to have data protection when using the same data files on the same minidisk.

To use virtual reserve/release, specify "V" in the mode operand of the MDISK directory statement. Also subject to virtual reserve/release processing are the virtual machine users who use the same minidisk by way of LINK statements.

By using the VM/370 virtual reserve/release support, one operating system running in a virtual machine can prevent other operating systems running under the same VM/370 system from accessing the reserved minidisk. However, a minidisk protected by virtual reserve/release support may not be protected from access by an operating system running on other processors.

Reserve/Release Support Considerations

When using VM/370 reserve/release support, note the following considerations:

- Shared Minidisks

  For devices shared between processors, volumes mounted on these devices can contain only one minidisk against which the virtual machine issues reserve CCW commands. (A minidisk may encompass all or part of that one volume.)

- Reserved Devices

  Do not place spooling and paging minidisks on volumes that will be reserved.

  To reserve devices between processors, define them with separately addressable paths. (Omit the ALTCU operand on the RDEVICE macro instruction and the ALTCH operand on the RCTLUNIT macro instruction during system generation.)

- Real Reserved Devices

  When using real reserve/release support, define the devices to be reserved with separate paths, not alternate path support.

- Minidisks

  When using virtual reserve/release support, each minidisk is protected. Thus, any number of minidisks located on the same volume can be protected. In addition, alternate path support can be defined for the real device on which the minidisk is located, provided other processors do not share the same volume.

- Single Real Processor

  Within a single processor, reserve/release CCW commands permit several operating systems running as virtual machines under one VM/370 system to use both virtual and real reserve/release to protect data from one another. Real reserve/release support is for dedicated devices.

Example -- Reserve/Release for Dedicated Volumes

In this example, 230 and 330 are alternate device addresses for a particular DASD to be shared by USERA and USERB (two virtual machines running on the same real computing system). To share this device:

1. Generate the virtual machine operating system for USERA to support both the device at 230 (two-channel switch) and the reserve/release software.
2. Generate the virtual machine operating system for USERB to support both the device at 330 (two-channel switch) and the reserve/release software.
3. Generate VM/370 as though 230 and 330 were different devices (with different control units and channels).
4. Issue the CP ATTACH command to attach device 230 to USERA and device 330 to USERB.

Note: If the system generated for USERB is to run in a real machine, rather than a virtual machine:

- Generate the VM/370 system with device 230 but not 330.
- Issue the CP ATTACH command to attach device 230 to USERA.

In both cases:

- The device addresses generated for systems to run in a virtual machine need not be the same as on the real machine.
- The devices used by virtual machines must be dedicated (attached or defined with a DEDICATE statement in the VM/370 directory).

While theoretically possible, do not share the CP SYSRES and any other CP-owned disk between two processors.

Summary of Reserve/Release Support

VM/370 checks all CCW commands passed by operating systems running in virtual machines. It bases reserve/release CCW command processing on: the type of device, the presence or lack of alternate path support, and whether the MDISK statement in the VM/370 directory contains a "V" on the mode operand. For the hardware to execute the reserve/release CCW commands, the two-channel switch special feature must have been installed. Depending upon the various combinations of these items, VM/370 either permits the reserve CCW command to execute on the hardware or changes the reserve CCW command to a sense CCW command. To determine the conditions when a "reserve" is changed to a "sense" CCW command, refer to Figure 2.

Type of Device	Alternate Path Support	Reserve/Release Executes in the Hardware (2-4 Channel Switch)	Virtual Reserve/ Release Requested (V Added to Mode in MDISK)	CCW Comnd Sent by VM/370 to Device	Note
Dedicated DASD or Tape	Not defined	Not applicable	Not applicable	Reserve	1
	Defined	Not applicable	Not applicable	Sense	2
Minidisks	Not defined	Yes	No	Reserve	1
	Not defined	Yes	Yes	Reserve	1
	Not defined	No	No	Reserve	3
	Not defined	No	Yes	Sense	4
	Defined	Not applicable	Not applicable	Sense	5

[1]Normal Operation -- The command is passed unchanged to the hardware.

[2]When the VM/370 system has been generated with alternate path support for those devices, it prevents the devices from being reserved. This action causes VM/370 to avoid a possible channel lockout. VM/370 does not return any indication of this action to the operating system issuing the CCW command that the device was not reserved.

[3]Without the two-channel switch special feature, VM/370 sends the reserve/release CCW command unchanged to the hardware. However, the hardware rejects the command and does not reserve the device.

[4]Before sending the command to the hardware, VM/370 changes the reserve CCW command to a sense CCW command and places a virtual reserve on the minidisk. The real device is not reserved. The virtual reserve prevents other operating systems running under the same VM/370 system from accessing the minidisk; however, these same virtual operating systems may reserve other minidisks located on the same real volume. Because the two-channel switch feature is not installed on the channels, only one address path goes to the device from the VM/370 processor. This path allows VM/370 virtual reserve/release processing to send a sense CCW to the device, although the reserve CCW command would be rejected by the hardware.

[5]When alternate paths to a device have been defined (by the ALTCU operand on the RDEVICE macro instruction and the ALTCH operand on the RCTUNIT macro instruction), VM/370 changes reserve/release CCW commands to sense CCW commands to prevent a possible channel lockout.

Figure 2. Summary of VM/370 Reserve/Release Support

ALTERNATING BETWEEN OPERATING SYSTEMS

A virtual machine user may require the facilities of more than one operating system during a single terminal session.

When running an operating system from a terminal, use the CMS editor to create and modify job streams and to analyze the results and output.

Application programmers who normally use CMS to interactively create, modify, and test programs, may require facilities for compilation or execution that are not supported or available in CMS.

The technique described in this topic uses multiple operating systems consecutively. Job control cards, compiler or assembler source programs, and test data streams are created and modified at the terminal under control of the CMS editor. The job stream is then executed, by passing control to an appropriate operating system that has the necessary facilities.

In this way, the programmer uses the terminal-oriented facilities of CMS to create and update source programs and JCL. When ready to compile or test, he can give control of his virtual machine to the operating system. After execution is finished, he can give control back to CMS to selectively scan and display printer and punch output at the terminal.

This approach assumes that the programmer has created source program files and data files under CMS. To execute under another operating system (in this example, OS), the programmer must also create JCL records that specify the compilation, link editing, or execution, as appropriate. These records are created under CMS and named with a distinctive filename and filetype (for example, PLICOMP JCL). Job control records, source program files, and data files can then be merged together in the virtual card reader to form a single OS job stream. The CP and CMS commands (shown in Figure 3) create and transfer this job stream.

Transferring Output

The CP SPOOL command transfers subsequent (not currently existing) card images from the virtual card punch of one virtual machine to the virtual card reader of that same or some other virtual machine. During this time, no real cards are punched or read; VM/370 manages the transfer of CMS card-image data files through disk spooling operations only.

Figure 3 shows how to punch files to the virtual machine's card reader. The virtual machine is in the CMS environment at the start of the example. The command "SPOOL 00c cont eof" specifies that reading be continuous until all files spooled to the virtual machine are exhausted and the virtual end-of-file button on the reader is pushed. NOHEADER specifies that no special control cards are to be inserted at the beginning of each punched file. Virtual device 230 is an OS system volume. Virtual device 231 contains the OS job queue, SYS1.SYSJOBQE. All standard CMS and OS responses are omitted from the example; however, the OS READY message is included to more fully illustrate the IPL sequence. Also, assuming that the user has a 2741, he must press the attention key before entering each OS command. The attention interruptions are not shown in Figure 3.

```
CMS
cp close 00c
cp purge 00c all
cp close 00d purge
cp spool 00d to * cont
punch jobcard jcl (noheader)
punch pliccmp jcl  (noheader)
punch plimain pli  (noheader)
punch asmcomp jcl  (noheader)
punch asmsub assemble  (noheader)
punch linkgc jcl  (noheader)
punch godata dat (noheader)
punch slshstar jcl (noheader)
cp spool 00d nocont
cp close 00d
cp spool 00c cont eof
cp ipl 230

Note:  The following are issued once under OS control:

IEE007A READY
set date=xx.355,Q=(231)
start rdr,00c
start wtr,00e
start
```

Figure 3. OS Job Stream Transfer

To transfer files between systems, the user must have access to both operating systems being used. Access to both systems can be provided either in the virtual machine's VM/370 directory entry, or dynamically before loading the new system.

Figure 4 illustrates a virtual machine configuration and the corresponding VM/370 directory control statements. Virtual device addresses 190 and 191 contain the CMS system and user disk area. Virtual device addresses 230 and 231 contain the OS system and user disk area. The two systems use a common card reader, card punch, printer, and console.

```
USER OS2 PASSWORD
 ACCOUNT NUMBER BIN16
  CONSOLE 01F 3215
  SPOOL  C 2540 READER
  SPOOL  D 2540 PUNCH
  SPOOL  E 1403
  LINK JFK 230 230 R
  LINK CMSSYS 190 190 RR
  MDISK 231 2314 120 82 UDISK1 WR
  MDISK 191 2314 101 10 UDISK1 WR RPASS WPASS
```

Figure 4. Directory Entry for Alternating Between Operating Systems

Configurations for Alternating Between Operating Systems

Users can alternate between operating systems more simply if:

- Devices used by both systems are supported at the same device address.

--and--

- Common addresses are not used to support different devices.

If these two conditions are not met, the user must modify the virtual machine configuration before each IPL of a new system.

If the two systems require online typewriter keyboards at different addresses, use the CP DEFINE command to change the address of the virtual system console. For example: The OS system (specified above) requires an online typewriter keyboard at address 01F, while the CMS system probably has its console at address 009. In this case, issue this command before loading 230:

```
cp define 009 as 01f
```

Because CMS automatically communicates with any valid multiplexer address, a user can leave the console at 01F and satisfy both systems.

If the systems expect different device types at the same address, the common address must be assigned to the appropriate device each time a new system is loaded. If CMS is running with a disk at address 191 and OS is generated to support a 3330 at that address, issue the following command before loading OS:

```
cp detach 191
```

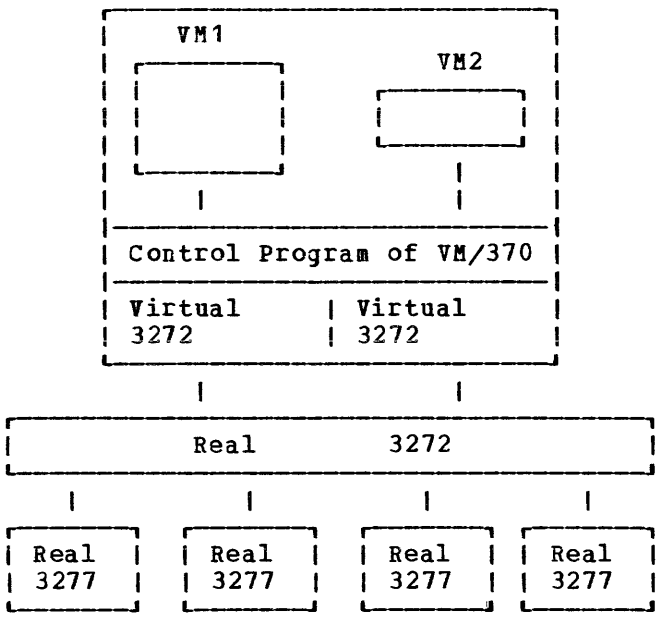
An appropriate device can then be added to the virtual machine at address 191. Add the device either before loading or in response to a mount request from the OS system.

Note: For direct access storage devices, this procedure is necessary even if both systems support the same device type at the same address. Except for VSAM disks, the disk format used by CMS is unique. It is not compatible with that of other operating systems. Files can be shared between CMS and OS or DOS only through VM/370 spooling or through VSAM data sets.

MULTIPLE-ACCESS VIRTUAL MACHINES

Multiple-access programs execute in a virtual machine and directly control terminals. These terminals do not have to be supported by VM/370 as virtual operator consoles, but they may be of any type supported by the virtual machine. These programs use lines that are either dedicated to the virtual machine (by the directory entry) or assigned to the virtual machine dynamically.

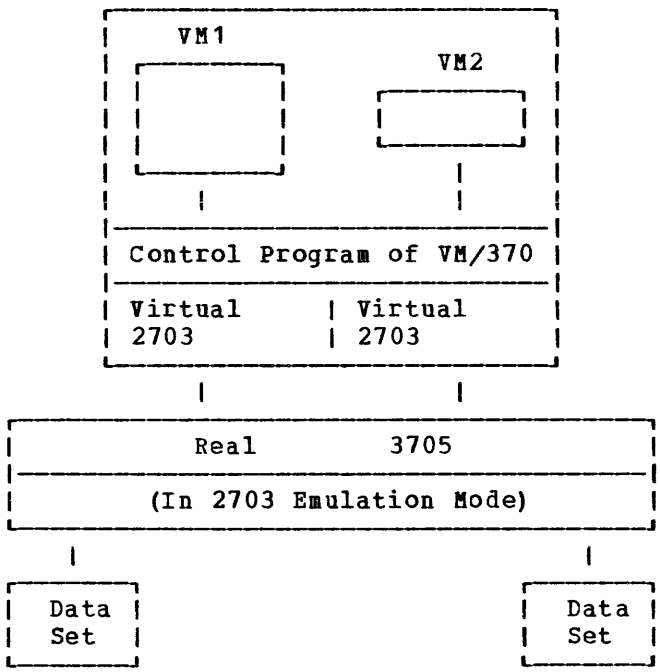
For example: Figure 5 shows two multiple-access systems (controlled by virtual machines VM1 and VM2). While each system controls real 3277s by using part of the real 3272, the real 3272 appears to both virtual machines as though they each have sole control of it. (The virtual system consoles of VM1 and VM2 are not shown.)



Note: Users can define virtual lines for a virtual machine. Except when running a 3704 or 3705 in Network Control Program (NCP) mode, these lines are a subset of the lines controlled by a real transmission control unit (TCU).

Figure 5. Virtual Devices: Local 3270 Terminals

Except when running a 3704 or 3705 in NCP mode, a subset of the lines of a real transmission control unit (TCU) can be defined as virtual lines for a virtual machine, as shown in Figure 6.



Note: Two lines on the real 3705 are defined as virtual lines for two virtual machines named VM1 and VM2. The remaining lines may support virtual operator consoles.

Figure 6. Virtual Devices: Remote Terminals

As shown in Figure 7, the virtual machine operating system may be one like VM/370 itself, or TSO, that supports a number of remote terminals.

To assign a real line as a virtual line, the terminals supported by the virtual machine's operating system are of the same type as those supported by VM/370 as virtual system consoles. To make this assignment, define the virtual lines either in the virtual machine's VM/370 directory entry (via the SPECIAL control statement) or add them to the logged-on virtual machine (via the CP DEFINE command).

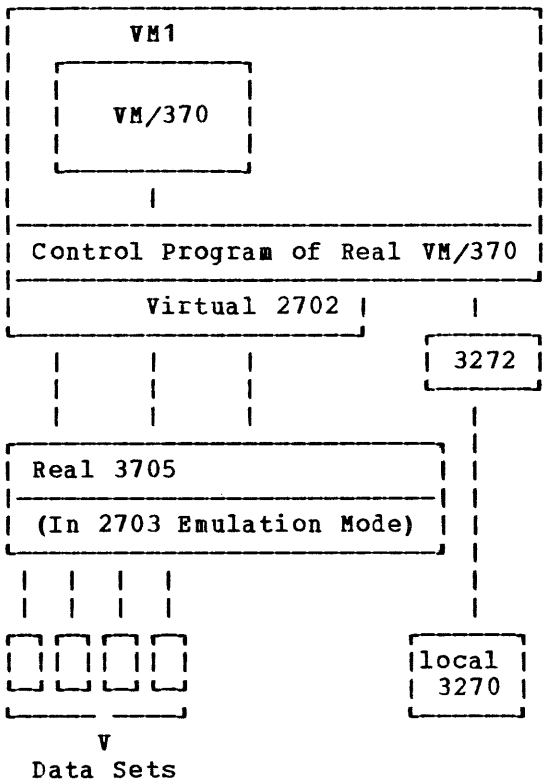


Figure 7. A Virtual VM/370 Multiple-Access System

Figure 8 illustrates a VM/370 directory entry for a multiple-access virtual machine to run VM/370 under VM/370.

```
USER VM370 PASSWORD 1M
  OPTION REALTIMER ECMODE
  CONSOLE 01F    3215
   SPOOL   00C   2540     READER
   SPOOL   00D   2540     PUNCH  B
   SPOOL   00E   1403     A
   DEDICATE 190 SYSRES
   DEDICATE 191 SYSWRK
   SPECIAL 080   2702     IBM
   SPECIAL 081   2702     IBM
   SPECIAL 082   2702     IBM
   SPECIAL 083   2702     IBM
   SPECIAL 070   3270
```

Figure 8. Directory Entry for a Multiple-Access Virtual Machine Running VM/370 under VM/370

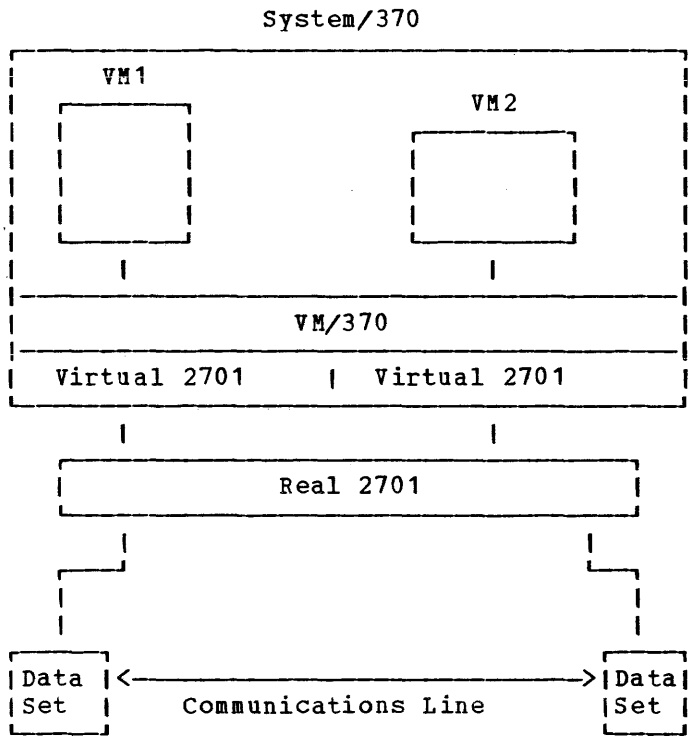
To connect a terminal supported by both VM/370 and a multiple-access system, use the CP DIAL command. Such terminals can be on either non-switched or switched lines. To connect a terminal to the virtual machine defined in Figure 8, enter this command:

```
dial vm370
```

The VM/370 system matches the terminal type to an equivalent virtual line that is available and enabled (in this example, 070, 080, 081, 082, or 083). Once a connection is made, the virtual machine controls the terminal to which it is logically connected (in this example, the VM/370 virtual machine). It remains connected until logoff using standard logoff procedures or until the virtual machine is forcibly logged off. Once logged off, the user is then free either to log onto VM/370 or to use the DIAL command to contact another multiple-access system.

Dial-up terminals supported by a multiple-access system may be of a different type than those supported by VM/370 as virtual system consoles. Such terminals must be on switched lines, and the CP DIAL command cannot be used. Users must dial the multiple-access system's telephone numbers directly.

As shown in Figure 9, a communications system can be tested by using multiple virtual machines in place of multiple real machines. For example: While there exists a single two-line 2701 on the real machine, the virtual 2701 units could each be defined as a one-line 2701.



Note: This figure assumes that the real 2701 transmission control unit is equipped with the appropriate data sets and line capability.

Figure 9. A Communications Test System

Figure 10 illustrates a virtual transmission control unit running remote 3270 units.

When the terminals supported by the multiple-access system are not those supported by VM/370 as virtual operator consoles, the real line appearances must be one of the following:

- Defined in the VM/370 directory entry for the virtual machine via the DEDICATE control statement; for example:

  DEDICATE vaddr raddr

  where: vaddr is the virtual address, and raddr is the real address of the appropriate line appearance on the real transmission control unit.

  -- or --

- Attached to the virtual machine by an operator with privilege class B; for example:

  attach raddr to vm1 as vaddr

  where: raddr is the real address of the appropriate line appearance on the real transmission control unit, and vaddr is the address of the line appearance as generated in the virtual machine operating system.

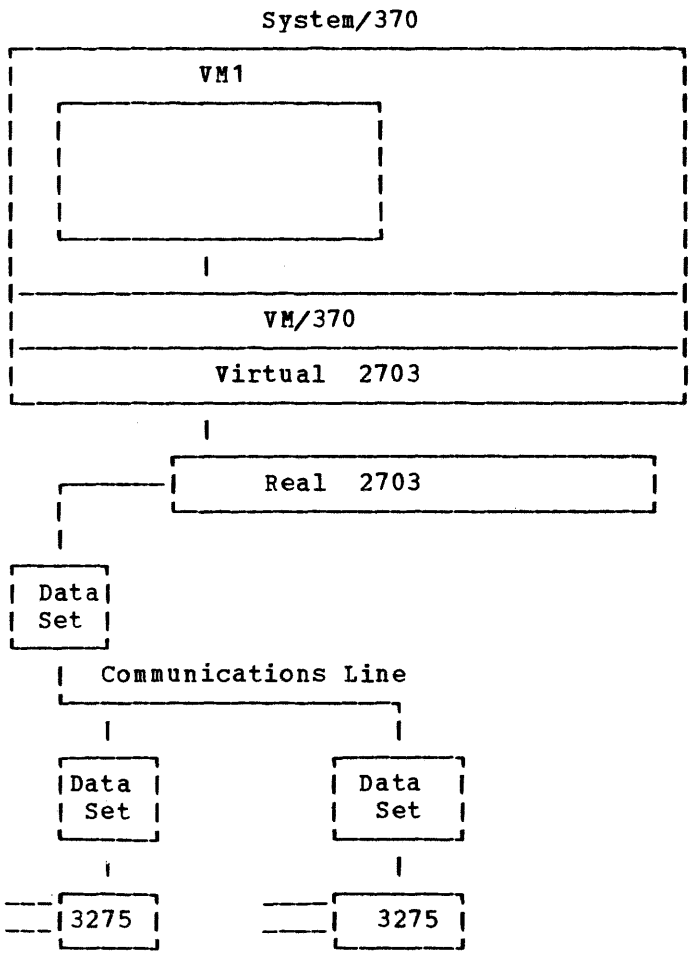


Figure 10. A Virtual 2703 TCU Controlling Remote 3270 Terminals

Performance Considerations

When virtual machine activity is initiated on an infrequent or irregular basis, such as from a remote terminal in a teleprocessing inquiry system, some (or all) of its virtual storage may be paged out before the virtual machine begins processing. The paging activity required for the virtual machine to respond to the teleprocessing request may increase the time required to respond to the request.

Use the locked pages or reserved page frames options to improve performance.

If the program must be run in the dynamic paging area, then locking specific pages of the virtual machine into real storage may ease the problem. However, besides page zero and the page containing the TP interruption handler, it is not always easy or possible to identify which specific pages are always required.

A more flexible approach than locked pages is the reserved page frames option. When a temporarily inactive virtual machine having this option is reactivated, these page frames are immediately available. If the program code or data required to satisfy the request was in real storage at the time the virtual machine became inactive, no paging activity is required for the virtual machine to respond.

For details about the locked pages and reserved page frames options, refer to the VM/370 System Programmer's Guide.

THE ASP VIRTUAL MACHINE

When using the OS asymmetric multiprocessing system (ASP), an installation may find virtual machines useful in two ways.

The first way, as shown in Figure 11, has a virtual ASP system that can be run by two virtual machines (VM1 and VM2) using a virtual channel-to-channel adapter (CTCA).

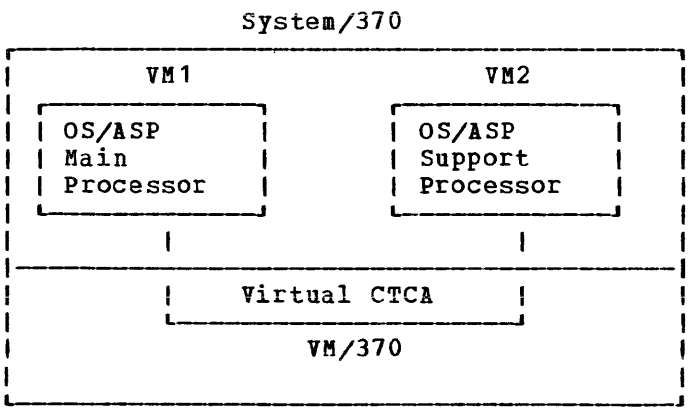


Figure 11. Two ASP Virtual Machines

The virtual ASP system (VM1 and VM2) shown in Figure 11 may be used in one of two ways: (1) to install and test a new ASP release, or (2) for ASP system testing in a virtual environment concurrent with normal production. The virtual ASP system eliminates the need to dedicate the real ASP system for new system testing.

The VM/370 directory entry for each of the virtual ASP processors must contain a statement defining a virtual channel-to-channel adapter in the form:

```
SPECIAL  280 CTCA
```

where: 280 is the address of the channel-to-channel adapter as generated in the operating system.

When both virtual ASP machines are logged onto VM/370, the CP COUPLE command must be issued by one of the virtual machine operators:

```
couple 280 to vm2  380
```

where: 280 is the address of VM1's virtual channel-to-channel adapter, VM2 is the userid of the second virtual machine, and 380 is the address of VM2's virtual channel-to-channel adapter. After the channels are coupled, the operator of each virtual machine can then load his operating system and start running ASP.

The second way, as shown in Figure 12, has an additional virtual machine (VM3), with a real channel-to-channel adapter to a real System/360 or System/370, running as either the main or support processor in a production ASP system.

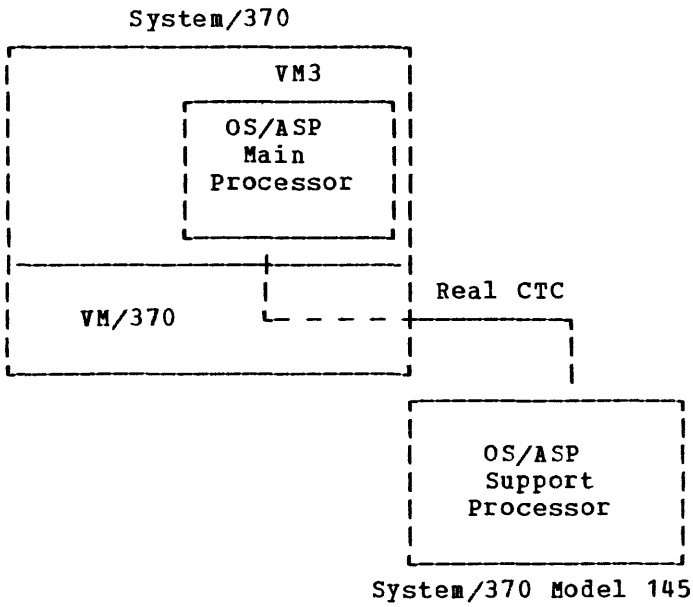


Figure 12. One Real and One Virtual ASP Machine

Define the real channel-to-channel adapter in the VM/370 system generation procedure by using the RDEVICE macro instruction with a device type of CTCA (DEVTYPE=CTCA). The virtual machine (VM3) must have this device assigned to it before the IPL. Make this assignment by using the DEDICATE statement in the virtual machine's VM/370 directory entry, such as:

```
DEDICATE 280 380
```

where: 280 is the address of the channel-to-channel adapter as generated in the OS system, and 380 is the address of the real channel-to-channel adapter as specified in the VM/370 system generation procedure.

If no DEDICATE statement for the channel-to-channel adapter appears in the virtual machine's directory entry, a resource operator with privilege class B must attach the real channel-to-channel adapter to the virtual machine.

Note: For further information on the virtual channel-to-channel adapter, refer to the description of the COUPLE, DEFINE, and DETACH commands in the VM/370 CP Command Reference for General Users.

Performance Guidelines

When run in a virtual machine, the performance characteristics of an operating system are difficult to predict. This unpredictability is a result of the complex interaction of many factors that affect performance. These factors can be broadly classified into three groups:

- Configuration factors
- Workload factors
- VM/370 performance factors

Performance of any virtual machine may be improved by the choice of hardware configuration, operating system workload, and VM/370 performance options. While a specific virtual machine's performance may not equal that of the same operating system running stand-alone on the same System/370, in some situations the total throughput obtained in the virtual machine environment can be equal to, or better than, that obtained on a real machine.

Configuration Factors

These hardware configuration factors influence the performance of an operating system in a virtual machine:

- The System/370 model used.
- The amount of real storage available.
- The speed, capacity, and number of paging devices.
- The degree of channel and control unit contention, as well as arm contention, affecting each paging device.
- Whether virtual machine assist or VM/370 extended control-program support is installed on the hardware and enabled.
- Interference between system paging devices and devices for processing a user's I/O requests.

When discussing these performance factors, this discussion assumes that the reader is familiar with the need to design an optimal configuration for a specific workload and operating system.

When moving a specific workload and operating system to the virtual machine environment, an installation should plan for an increased need in such hardware requirements as real storage, DASD space, and processor size. While VM/370's overhead for dispatching, scheduling, and paging may be relatively small, its overhead for simulating privileged instructions may be considerable.

When not operating under VM/370, an operating system runs directly on its own hardware (native mode) and manages its resources through the use of privileged instructions (such as SVC and LPSW) issued in supervisor state. When executing in a virtual machine, VM/370 dispatches the operating system in problem state, and any privileged instructions issued by the virtual machine cause a real privileged instruction exception interruption. This interruption transfers control to VM/370 to simulate the instruction. The amount of work done by VM/370 in analyzing and handling a virtual machine-initiated interruption depends upon the type and complexity of the interruption. Thus, any reduction in the number of privileged instructions issued by a virtual machine's operating system reduces the amount of extra work VM/370 must do to support that operating system.

Virtual machine assist support has been specifically designed to reduce VM/370's overhead associated with simulating privileged instructions. It is the single, most effective method for reducing privileged instruction simulation. Any installation that is going to run a production operating system under VM/370 should consider virtual machine assist as a prerequisite for improving performance. Other steps for improving performance (such as using specialized VM/370 performance functions) are of secondary importance compared to using virtual machine assist.

VM/370 extended control-program support (ECPS: VM/370) is a hardware assist function that provides support over and above that provided by virtual machine assist support. It improves VM/370 performance beyond that attained by virtual machine assist support by reducing VM/370's real supervisor state time needed to support virtual machines. ECPS: VM/370 is available only on certain System/370 models as listed in VM/370 Planning and System Generation Guide.

Workload Factors

These workload factors influence the performance of an operating system in a virtual machine:

- The type of operating system being used.
- The total number of virtual machines running under VM/370.
- The type of work each virtual machine is doing, especially the amount of I/O processing required.

By measuring and evaluating the effect of these workload factors on a specific configuration, an installation can understand their effect on performance and know which steps to take to improve performance.

To relate these measurement values to system workload for a specific configuration, an installation must define its workload. The definition of workload varies with the environment:

Environment	Workload Definition
Interactive time-sharing system	Arrival rate of transactions and the CPU time and working set size required for each transaction.
Batch system	Job throughput and resource requirements (CPU time, region or partition size, and number of EXCPs issued) for each job.

By using these workload definitions, an installation can measure its workload under VM/370 as follows:

Environment	Workload Measurement
CMS users under VM/370	Number of active users
Operating system under VM/370	User I/O requests executed

When both an operating system and CMS users run under the same VM/370 system, workload measurement depends upon which type of environment dominates the VM/370 system.

To measure workload performance in a specific configuration, an installation can use the Field Developed Program VM/370 Performance/Monitor Analysis program (5798-CPX). This program plots a number of important system variables (such as CPU usage, various contention measurements, and paging rates) against workload measurement for both the CMS and operating system workloads under VM/370. For a specific configuration, it allows an installation to relate processor usage, storage usage, and resource contention to the total system workload in both interactive and batch production environments.

By using this analysis program, an installation can eventually determine its optimum processor model, storage size, and I/O configuration for a specific workload. Thus, an installation may determine that it needs to do such things as: redistribute data sets to reduce arm contention, add control units and channels to reduce I/O contention, and add paging devices to reduce interference between system and user I/O processing.

VM/370 Performance Factors

These specialized VM/370 software techniques influence the performance of an operating system in a virtual machine:

- Whether VM/VS handshaking is used.
- The type and number of VM/370 performance options in use by one or more virtual machines.
- Whether the VM/370 System Extensions Program Product (5748-XE1) is used.

VM/VS Handshaking: VM/VS handshaking (described earlier in this section under the topic "VM/VS Handshaking") permits instructions issued by an operating system in a virtual machine to be processed directly by the processor. It also permits VM/370 to simulate privileged instructions.

VM/370 Performance Options: After measuring the performance of both VM/370 and the virtual machines it supports, the system analyst and the general user can each use certain VM/370 performance options. These options allow them to create a special performance environment for one or more virtual machines. The options allow:

- The system analyst to redistribute system resources either to balance inequities or to favor one virtual machine over another.
- The general user to improve the performance for his virtual machine.

The VM/370 system operator, on behalf of the system analyst, can give certain options to a specific virtual machine to improve its performance over other virtual machines. A general user has certain performance options that give limited control over his virtual machine. The options available to the system operator and the general user are:

System Operator	General User
Locked pages option	Virtual machine assist
Reserved page frames	VM/370 extended control-program support
Priority	Virtual=real option[1]
Favored execution option	

In the following list, the first option and either of the next two options can be applied to only one virtual machine at a time.

- Favored execution with guaranteed percentage
- Reserved page frames
- Virtual=real option[1]

The following options can be applied to as many virtual machines as desired:

- Basic favored execution (without guaranteed percentage)
- Priority
- Virtual machine assist
- VM/370 extended control-program support (ECPS: VM/370)
- Locked pages

For basic information about these options, refer to the VM/370 System Programmer's Guide. For details about specifying the options for the system operator, refer to VM/370 Operator's Guide. For details about specifying the options for the general user, refer to VM/370 CP Command Reference for General Users.

System Extensions Program Product: The System Extensions Program Product (5748-XE1) provides several performance-related additions to the VM/370 system control program. For certain environments, these additions:

- Improve throughput
- Provide better terminal response

---

[1]This option cannot be specified in a command. To obtain it, a general user requests the VM/370 system programmer to specify it on the OPTION control statement (VIRT=REAL option) for the user's virtual machine directory entry.

- Reduce overhead associated with maintaining shadow page and segment tables
- Improve performance for a production virtual storage operating system running under VM/370
- Increase throughput of MVS running under VM/370 on an attached processor or multiprocessor system

For more details about this program product, refer to the VM/370 System Extensions Program Product: General Information Manual, GC20-1827.

PERFORMANCE MEASUREMENTS

Performance measurements apply to both the VM/370 system and the individual virtual machine. How well the system responds to the needs of the users is of prime importance to the system analyst. How efficiently the individual virtual machine makes use of the allotted storage, processor, and I/O facilities is of prime importance to the general user.

VM/370 provides certain CP commands (INDICATE and MONITOR) that allow both VM/370 and virtual machine performance to be tracked and measured; other commands allow the setting of certain options to improve performance. To reduce and help analyze the data produced by the MONITOR command, the Field Developed Program VM/370 Performance/Monitor Analysis program (5748-CPX) is available. By using this program, an installation can eventually determine its optimum processor model, storage size, and I/O configuration for a specific workload.

For a complete description of the INDICATE and MONITOR commands, refer to the VM/370 System Programmer's Guide.

EMPHASIZING INTERACTIVE RESPONSE TIMES

Most conditions for good performance, established for the time-sharing and batch systems, apply equally well to mixed mode systems. However, two major factors make any determination more difficult to make. First, get evidence to show that, in all circumstances, priority is given to maintaining good interactive response, and that nontrivial tasks really execute in the background. Second, background tasks (no matter how large, inefficient, or demanding) should not be allowed to dominate the overall use of the time-sharing system. In other words, in mixed mode operation, get evidence to show that users with poor characteristics are discriminated against for the sake of maintaining an efficient system for the remaining users.

A number of other conditions are more obvious and straightforward. For example: Measure response time and determine at what point it becomes unacceptable and why. Studies of time-sharing systems have shown that a user's work rate is closely correlated with the system response. When the system responds quickly, the user is alert, ready for the next interaction, and thought processes are uninterrupted. When the system response time is poor, the user loses concentration.

Generation Procedures Under VM/370

VM/370 can help considerably throughout the system generation process. Probably VM/370's biggest advantage is the ability to generate the system under VM/370 without disturbing the normal production activity.

The system programmer (or whoever is responsible for the operating system) can log onto his own virtual machine and go through the generation steps at his own pace while the daily work is being processed. He can use the VM/370 CMS editor to create and update the job streams that are used during system generation. Whenever the system generation process requires, he can use CMS EXEC procedures to pass these saved job streams to the test system. When the system is tested, it can be placed online, replacing the previous version with minimal interruption to the production activity.

For a discussion of the CMS editor and EXEC facilities, refer to the VM/370 CMS User's Guide. For details about the system generation procedure for DOS/VS and OS/VS under VM/370, refer to these system-dependent sections in this publication.

Creating VM/370 Directory Entries

To allow a virtual machine to exist in the VM/370 system, the VM/370 system requires a directory entry definition. Each definition is kept in a directory entry source file (filetype DIRECT) on a user minidisk. An installation must use the VM/370 directory program to convert these source definitions in the VM/370 system directory file (usually on the system residence disk) that contains one entry for each virtual machine.

Each directory entry contains a number of directory control statements that define the virtual machine's configuration and other operational characteristics to VM/370. In general, a virtual machine configuration defined in the directory consists of the following:

- Virtual storage, console, and processor
- Direct access storage devices
- Unit record devices
- Other devices

Figure 13 shows the relationship of a directory entry to both the VM/370 system's real devices and the virtual machine's virtual devices. The installation must keep both the source and system directories updated. As users submit additions and/or changes, the installation must either create new or update current directory entries. This updating can be done by using the VM/370 Directory Maintenance Program Product (5748-XE4), the CMS editor, or punched cards. (For more details about this program product, refer to the VM/370 Directory Maintenance Program Product General Information Manual, GC20-1836.)

To create directory entries for operating systems running in virtual machines, installations must consider both the general and unique requirements for specifying directory entries. For general details about specifying directory entries, refer to VM/370 Planning and System Generation Guide. For unique details about specifying directory entries for operating systems running in a virtual machine, refer to the following topic "Unique Directory Entry Considerations."

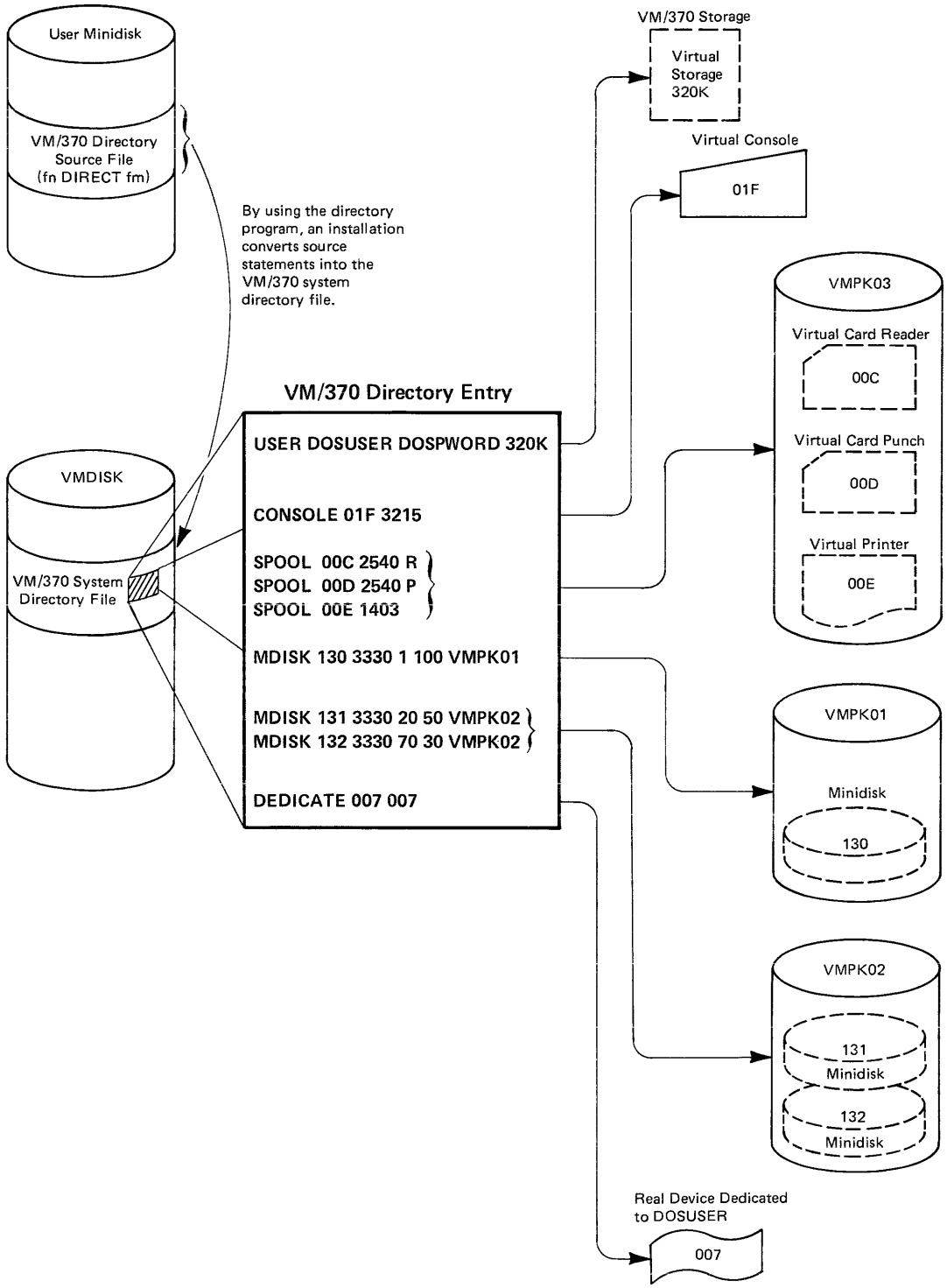


Figure 13. Relationship of VM/370 Directory Entries

UNIQUE DIRECTORY ENTRY CONSIDERATIONS

This topic lists directory control statements in their logical order of appearance in a directory entry. It describes only those statements with unique considerations for running an operating system in a virtual machine.

USER Control Statement

The USER control statement has no unique considerations for running an operating system in a virtual machine.

ACCOUNT Control Statement

The ACCOUNT control statement has no unique considerations for running an operating system in a virtual machine.

OPTION Control Statement

The OPTION control statement allows virtual machine users to specify certain options and features for their virtual machines.

ACCT Option

The ACCT option allows one user to charge another user for virtual machine resources. For example: If the machine is performing a batch type operation, a virtual machine user can generate job accounting cards for each job processed. To generate accounting cards for a virtual user, refer to the VM/370 System Programmer's Guide for a discussion of DIAGNOSE code X'4C'.

ECMODE Option

Specify the ECMODE option if the virtual machine uses an operating system that:

- Runs in extended control mode
- Uses dynamic address translation (DAT)
- Uses extended control registers other than zero
- Addresses I/O channels 6 through 15

If this option is not specified in the directory, a user can enter EC mode by issuing the CP SET command with the ECMODE operand:

```
#cp set ecmode on
```

When the ECMODE option is specified for a virtual machine, the saved segments of the virtual operating system are shareable.

ISAM Option

The ISAM option allows VM/370 to handle self-modifying channel programs that ISAM generates for some of its operations. If this option is not specified in the directory entry, users can obtain the ISAM facility by issuing the CP SET command with the ISAM operand:

```
#cp set isam on
```

The ISAM option must be specified if a user is:

- Using ISAM in an OS/PCP, OS/MFT, or OS/MVT virtual machine
- Using ISAM in a V=R parition or region of an OS/VS virtual machine
- Using VS1 handshaking with VS1 nonpaging

Do not specify the ISAM option if a user is:

- Using ISAM in a DOS or DOS/VS virtual machine
- Using ISAM in a V=V region of an OS/VS virtual machine

REALTIMER Option

Enter the REALTIMER option if the virtual timer is to be updated during virtual wait time as well as during virtual processor time. This option is required for operating systems running applications where certain interruptions are timer driven. If this option is not specified in the directory entry, a user can obtain this timing facility by issuing the CP SET command with the TIMER operand:

```
#cp set timer real
```

To turn off the option, issue:

```
#cp set timer off
```

SVCOFF Option

The SVCOFF option specifies that VM/370, rather than virtual machine assist or ECPS: VM/370, handle all SVC interruptions. To override this option, issue the CP SET command:

```
#cp set assist svc
```

Note: If the operating system uses SVC 76 for error recording, VM/370 handles the SVC 76 interruptions whether SVCOFF is in effect or not.

Virtual=Real Option

The virtual=real option may be desirable, undesirable, or mandatory. It is desirable when running a virtual machine operating system (like DOS/VS or OS/VS) that performs its own paging because it eliminates the possibility of double paging. The virtual=real option is not desirable when running an operating system in nonpaging mode with VM/VS handshaking in a virtual machine. It is mandatory to use the virtual=real option to allow programs that execute self-modifying channel programs or have a certain degree of hardware timing dependencies to run under VM/370.

The virtual=real area is set up at VM/370 IPL. The primary VM/370 system operator can release the area for use as part of the dynamic paging area. Once released, it cannot be reclaimed except by reloading VM/370. The virtual=real area must be released in total; that is, unused pages of the area cannot be selected for release.

There are several ways to use the virtual=real option effectively on a data communication system with no CCW translation (SET NOTRANS ON) that has multiple ports. Dedicate either the transmission control unit or communications lines to that system via the ATTACH command or by VM/370 directory assignment. Conversely, on a multiple port data communication virtual=real operation, virtual 270x lines (that is, lines assigned and used by the CP DEFINE and DIAL commands) operate with CCW translation. When VM/370 detects the use of nondedicated communication lines, it ignores the SET NOTRANS ON command.

For general information on specifying a virtual=real machine and on defining the VIRT=REAL option in a virtual machine's directory entry, refer to VM/370 Planning and System Generation Guide.

Note: Portions of the DOS/VS supervisor and OS/VS nucleus must be relocated above page zero to keep input operations from compromising VM/370's page zero. For a more detailed description of the problem and the suggested solutions for DOS/VS and OS/VS, refer to the "System Generation Recommendations" topic in the sections for DOS/VS and OS/VS in a virtual machine in this publication.

By specifying the VIRT=REAL option, the virtual machine is eligible to occupy VM/370's low storage. Thus, with the exception of page 0, all other virtual storage addresses correspond to the real storage addresses. VM/370's page 0 occupies the first 4096 bytes of real storage, and VM/370 relocates virtual page 0 to a position immediately following the area set aside for V=R operation (see Figure 14).

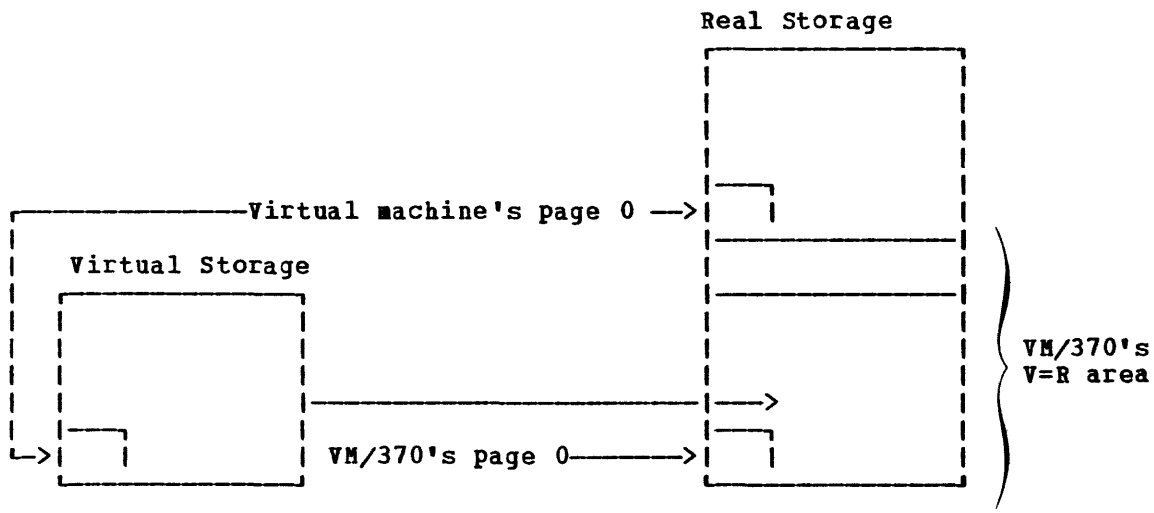


Figure 14. Virtual=Real Machine

This option can be specified for many virtual machines; however, only one virtual machine can occupy the V=R area at one time. If this option is specified and the V=R area is occupied when logging on, VM/370 creates the virtual machine in virtual=virtual mode and sends a message to inform the user of this development.

IPL Control Statement

If a virtual machine runs one operating system most of the time, a user can have that system automatically loaded each time he logs on. Use the IPL statement to identify the operating system to VM/370, such as by specifying the following:

```
ipl 350
```

The virtual address 350 represents the address of the device that contains the system to be loaded. Or, if the virtual machine's operating system has been "saved" (by using the CP SAVESYS command), specify:

```
ipl DOSVS
```

Where DOSVS is the name under which the system was saved.

Note: For the VM/370 system operator to automatically log onto a virtual machine (by using the class A or B AUTOLOG command), the virtual machine directory entry must contain an IPL control statement.

CONSOLE Control Statement

The CONSOLE control statement has no unique considerations for running an operating system in a virtual machine.

MDISK Control Statement

The MDISK control statement has no unique considerations for running an operating system in a virtual machine.

SPOOL Control Statement

The SPOOL control statement has no unique considerations for running an operating system in a virtual machine.

DEDICATE Control Statement

Use the DEDICATE control statement to provide a virtual machine with a corresponding real device. The virtual machine has sole use of the dedicated device.

Magnetic Tapes: A device such as a magnetic tape drive can be used by only one virtual machine at a time; therefore, specify it in a directory entry with a DEDICATE statement.

Example: The directory specifies:

```
DEDICATE 181 281
```

This statement allows the operating system to access the device at real address 281 via a virtual address of 181.

Spooling Devices: In most cases, spooling represents the most efficient way of handling the unit record input and output of many virtual machines. However, special cases may justify the dedication of a real unit record device to a single virtual machine.

One special case is when the virtual machine's operating system does its own spooling, such as POWER/VS under DOS/VS or JES under OS/VS. To eliminate double spooling of printer output, include a DEDICATE statement in the virtual machine's directory entry, such as:

```
DEDICATE 00E 002
```

This statement causes VM/370 to pass all virtual printer 00E output directly to the real printer at 002.

Another case where a user may want a unit record device dedicated to his virtual machine would be if the virtual machine produced a sufficient volume of output to keep the device busy.

Users can also have the system operator dynamically dedicate a unit record device to their virtual machine. First, send the system operator the message:

```
#cp msg operator pls attach punch at 00d
```

If a punch is free at 00d, the operator issues the command:

```
attach 00d to userid as 00d
```

When the device is attached, VM/370 sends a confirmation message to userid:

```
PUN 00D ATTACHED
```

When the device is no longer needed, issue the command:

```
#cp detach 00d
```

Unsupported Devices: The DEDICATE statement can be used to place a device that VM/370 does not support into a virtual machine's configuration. To dedicate a device, the device must:

- Be physically connected to the System/370
- Be supported by the virtual machine's operating system
- Not violate any of the restrictions contained in the VM/370 restriction section of the VM/370 Planning and System Generation Guide

For example: A directory entry can include the statement:

```
DEDICATE 007 012
```

where real address 012 could represent a 2671 Paper Tape Reader that is part of the System/370 on which VM/370 is running. If the operating system was generated with a 2671 defined at address 007, VM/370 handles the device and CCW address translation associated with reading from the device. The operating system in the virtual machine is responsible for error recovery and error recording procedures.

2305 Devices: When using the DEDICATE statement to attach a 2305 to a virtual machine, both the real and virtual addresses must refer to the first base device address on the unit. The first base address of the 2305 is 0 or 8 -- the resulting address appears as xx0 or xx8. However, when VM/370 processes the statement, it creates all eight addresses (0-7 or 8-F) for the 2305.

LINK Control Statement

The LINK control statement has no unique considerations for running an operating system in a virtual machine.

SPECIAL Control Statement

Use the SPECIAL control statement to add I/O devices that do not require corresponding real devices. Some examples are: magnetic tapes, channel-to-channel adapters, pseudo timers, communication lines, and devices that, while available to the System/370, are not supported by VM/370.

Installations can use the SPECIAL control statement to specify a virtual transmission control unit for a multiple-access operating system. For example: If the system requires three communication lines from a 2703, specify:

```
SPECIAL 061 2703 IBM
SPECIAL 062 2703 IBM
SPECIAL 063 2703 TELE
```

Before a terminal can communicate with a multiple-access system, the terminal user must issue the DIAL command:

```
dial userid
```

to connect to any available line port; or issue:

```
dial userid 062
```

to connect to a particular line.

Note: Of the three lines specified in the foregoing example, one was a teletypewriter line and two were IBM terminal lines. When the DIAL command is issued with no specific address, VM/370 connects the terminal to any available line as defined in the SPECIAL control statement; the line then belongs to the specified userid. If no lines are available or if all lines are busy, VM/370 issues an error message and does not make the connection. To drop a dialed line, a user must issue the CP RESET command.

DEFINING VIRTUAL DEVICES

When using the SPOOL, DEDICATE, and SPECIAL control statements to define virtual devices, specify virtual addresses that do not conflict or contend with the virtual control unit interface. This conflict or contention occurs because devices can require special I/O interface protocol from control units, such as for shared and nonshared subchannel operations. Putting devices that require different real control units on the same virtual control unit can result in a hung or busy condition. To avoid this problem, users must define (and separate) devices within their own control unit range.

For example: If the directory entry specifies:

```
SPOOL 102 3211
SPECIAL 103 3270
```

the control unit 0 on channel 1 controls both an unshared device (the 3211 printer) and a shared device (the 3270 display unit). Processing of channel programs involving these two devices can result in a hung or busy condition.

AUTOLOG FACILITY

AUTOLOG is a convenient way to initiate large production operating systems with many I/O devices that run under VM/370. The I/O devices needed by these operating systems require considerable contiguous storage space for the I/O control blocks established by VM/370. When these large operating systems are started after other, smaller users have been using VM/370, the contiguous storage space may not be available. When there is insufficient contiguous space, the logon of the virtual machine is successful; however, there may be an insufficient number of I/O devices to run the operating system and its application programs.

To ensure sufficient contiguous storage space, log on those virtual machines after loading VM/370.

- Have the VM/370 system operator issue the CP AUTOLOG command before enabling user terminals.
- Define the AUTOLOG1 virtual machine in the VM/370 directory. The AUTOLOG1 userid can be used to logon and load virtual machines that require substantial contiguous storage.

Using the CP AUTOLOG Command

Before enabling user terminals, the VM/370 system operator can issue the CP AUTOLOG command for each production virtual machine that requires substantial contiguous storage. The directory entry for the userid indicated by the CP AUTOLOG command must contain an IPL statement for the desired operating system. For more information about the CP AUTOLOG command, refer to the VM/370 Operator's Guide.

Defining AUTOLOG1 in the Directory

After the VM/370 console operator loads the VM/370 system, VM/370 initiates one predefined operating system to run as a virtual machine without operator intervention, provided these two conditions are met:

1. An AUTOLOG1 virtual machine is defined in the directory.
2. The AUTOLOG1 directory definition includes an IPL control statement specifying an operating system.

Note: The AUTOLOG1 facility initiates a virtual machine with an operating system in disconnect mode. If that virtual machine issues a READ command to its own unavailable console, VM/370 terminates the virtual machine. WRITE commands to an unavailable operator's console merely cause the loss of information that is not spooled; no termination occurs.

To use AUTOLOG1 to initiate several virtual machines, have the VM/370 directory statements load CMS for the AUTOLOG1 userid. The CMS PROFILE EXEC would contain several CP AUTOLOG commands. Each AUTOLOG command initiates one virtual machine containing a production operating system. When using the CP AUTOLOG command, the directory entries referenced by the CP AUTOLOG command must contain an IPL statement.

When the production virtual machine is loaded directly by an IPL statement in AUTOLOG1, an operating system user gains access to the virtual machine by logging on as AUTOLOG1 with the appropriate password.

When the production virtual machine is loaded (as a result of a CP AUTOLOG command in the CMS PROFILE EXEC), an operating system user gains access to the virtual machine by logging on with the userid specified in the CP AUTOLOG command.

When the user logs off, contiguous storage space is relinquished. If the user wants to keep the virtual machine's I/O blocks in contiguous storage and temporarily relinquish use of the virtual machine, the user issues the CP DISCONN command. To reestablish usage, the user issues the CP LOGON command to reconnect to the virtual machine.

Single System With AUTOLOG1

The following example uses the AUTOLOG1 facility with an IPL statement.

```
USER AUTOLOG1 PASSWORD 256K
     ACCOUNT ACCTNO BIN3
     IPL 350
     OPTION ACCT
          CONSOLE 01F 3215
          SPOOL 00B 2501
          SPOOL 00C 2540 R
          SPOOL 00D 2540 P
          SPOOL 00E 1403
          MDISK 350 3330 101 30 OSDOS1 W
          MDISK 351 3330 1 20 UDISK1 W
```

With these directory entries, the operating system would be logged onto the VM/370 system in disconnect mode. A user accesses the system by logging on as userid AUTOLOG1 with the appropriate password. To temporarily relinquish use of the system without relinquishing contiguous storage, the user issues the CP DISCONN command. To reestablish use, a user issues the CP LOGON command. Issuing the CP LOGOFF command releases the contiguous storage space containing the VM/370 I/O device control blocks supporting the operating system.

Multiple Systems With AUTOLOG1

In this example, AUTOLOG1 initializes CMS in a virtual machine. The virtual machines containing the production operating systems are automatically logged on in disconnect mode from the CMS PROFILE EXEC. The CMS PROFILE EXEC contains several CP AUTOLOG commands, one for each virtual machine to be loaded. For each userid identified in a CP AUTOLOG command, there must be an IPL statement in the VM/370 directory to load the appropriate operating system into the virtual machine. The last CP command in the PROFILE EXEC may logoff AUTOLOG1. The virtual machines are logged onto VM/370 in disconnect mode.

```
AUTOLOG1 Virtual Machine

    USER AUTOLOG1 PASSWORD 256K 1M AB
         ACCOUNT ACCTNO BIN1
         IPL CMS
              CONSOLE 009 3215
              SPOOL 00C 2540 R
              SPOOL 00D 2540 P
              SPOOL 00E 1403
              LINK VMSYS 190 190 RR
              MDISK 191 3330 1 10 UDISKA WR RPASS WPASS


PROFILE EXEC

    &CONTROL OFF NOMSG NOTIME PACK
    CP SPOOL CONSOLE START
    SET RDYMSG SMSG
    CP SPOOL PRINTER CLASS A
    CP SET EMSG TEXT
    CP SET LINEDIT ON
    CP AUTOLOG DOSUSER PASSWORD
    CP AUTOLOG DOSVUSER PASSWORD
    CP AUTOLOG OSUSER PASSWORD
    CP LOGOUT
    &EXIT
```

By having the preceding AUTOLOG1 directory entry and PROFILE EXEC, the DOSUSER, DOSVUSER, and OSUSER virtual machines (specified in the PROFILE EXEC) are now logged onto the VM/370 system in disconnect mode. A user accesses these virtual machines by logging on with the userid of DOSUSER, DOSVUSER, or OSUSER along with the appropriate password. To temporarily relinquish use of one of these virtual machines without relinquishing contiguous storage, a user issues the CP DISCONN command. To reestablish use, a user issues the CP LOGON command. Issuing the CP LOGOFF command releases the contiguous storage space. This space contains the VM/370 I/O device control blocks that support the virtual machine being logged off.

SAMPLE DIRECTORY ENTRIES

This topic shows some useful virtual machines that can be defined when running operating systems in virtual machines. Sample directory entries for running specific operating systems under VM/370 are in the operating system dependent sections in this publication.

A Multiple-Access Virtual Machine

The following directory entry represents a multiple-access TSO system configured to handle one to four concurrent remote terminals and one local 3270. It has been given the VIRT=REAL option to improve response time.

```
USER TSOSYS PASSWORD 384K
     ACCOUNT ACCTNO BIN8
     IPL 290
     OPTION REALTIMER VIRT=REAL
          CONSOLE 01F 3215
          SPOOL 00C 2540 R
          SPOOL 00D 2540 P
          SPOOL 00E 1403
          DEDICATE 290 TSOSYS
          DEDICATE 291 TSOWRK
          SPECIAL 070 3270
          SPECIAL 080 2702 IBM
          SPECIAL 081 2702 IBM
          SPECIAL 082 2702 IBM
          SPECIAL 083 2702 TELE
```

A VM/370 Virtual Machine (TESTSYS)

The directory entry for this virtual machine has the ECMODE and REALTIMER options, allowing its user to check a new CP nucleus before moving that nucleus to the production system. TESTSYS contains two minidisks, 350 and 351. These disks are exact copies of the real system residence and scratch volumes. They are formatted and allocated so that the real system can spool and page on these disks. If a user needs additional disks, link to them before loading the virtual VM/370 system.

```
USER TESTSYS PASSWORD 512K
     ACCOUNT ACCTNO BIN11
     OPTION ECMODE REALTIMER
          CONSOLE 01F 3215
          SPOOL C 2540 R
          SPOOL D 2540 P
          SPOOL E 1403
          LINK VMSYS 190 190 RR
          MDISK 191 3330 161 10 UDISKA WR RPASS WPASS
          MDISK 350 3330   1 15 SYSWRK WR RPASS WPASS
          MDISK 351 3330  16 20 SYSWRK WR RPASS WPASS
```

Summary

Tc run any cperating system in a virtual machine, an installation should:

- Design new and existing application programs to operate efficiently in a paging environment; that is, have them use VM/370 paging instead of DOS/VS or OS/VS paging.
- Reduce a virtual machine's I/O operations.
- Use VM/370 services for performance and communication, such as the VM/370 virtual machine options and VMCF.

When running specific multiprogramming operating systems under VM/370 (such as DOS/VS or OS/VS), an installation should consider how that system interacts with VM/370 -- especially when that system has a page wait or I/O wait. To interact with these systems, VM/370 provides VM/VS handshaking for certain DOS/VS and VS1 systems, and the diagnose interface fcr virtual operating systems, such as DOS/VS and OS/VS.

Other areas to consider when running multiprogramming operating systems under VM/370 are spooling, channel model-dependencies, whether to use multiple or alternate consoles, and the states or conditions of virtual devices (dedicated, shared, and spooled).

VM/370 also supports alternate paths, multiple-access virtual machines, cperating systems using DASD reserve/release, and the ASP virtual machine. Installations can also alternate between operating systems under VM/370.

While difficult to predict, performance of any virtual machine may be improved by the choice of hardware, operating system, and VM/370 opticns. VM/370 also provides the INDICATE and MONITOR commands to track and measure both VM/370 and virtual machine performance.

VM/370 can help considerably throughout the system generation process. Its biggest advantage is allowing an installation to generate a system under VM/370 without disturbing production activity.

To allow virtual machines to access the VM/370 system, the VM/370 system requires a file of directory entries that contains one entry for each virtual machine. Each directory entry contains a number of directory control statements that define the virtual machine's ccnfiguratien and operational characteristics to VM/370. Some directory statements have unique considerations when running an operating system in a virtual machine. There is an AUTOLOG facility to automatically initiate large productien operating systems with many I/O devices under VM/370.

Section 2. VM/370 in a Virtual Machine

This section describes how to update and test a VM/370 system in a virtual machine. After testing, use the DASD dump restore (DDR) program to dump the virtual CP (VM/370) system to tape. Then, restore that virtual CP system to the real system residence disk. After performing these steps, an installation is ready to execute the new version of VM/370 with a minimum amount of real processor time.

VM/370 Directory Definition

Before an installation can test VM/370 in a virtual machine, it must first have a VM/370 directory entry for a VM/370 virtual machine. The virtual directory need only specify a minimum number of users that are sufficient to perform the testing. It is usually beneficial to define an operator's virtual machine that is large enough and varied enough to perform all necessary functions. This specification allows most virtual testing to be done from one userid. It does not require several userids to dial into this system to accomplish a test.

In the following sample directory entry, assume that TESTSYS is the userid for this virtual machine. TESTSYS has the options and configuration necessary to define a minimum system for initializing VM/370 in a virtual machine. A sample VM/370 directory entry for TESTSYS would be:

```
USER TESTSYS PASSWORD 512K
  ACCOUNT NUMBER BIN11
  OPTION ECMODE REALTIMER
    CONSOLE 01F 3215
    SPOOL C 2540 READER
    SPOOL D 2540 PUNCH
    SPOOL E 1403
    LINK CMSSYS 190 190 R
    MDISK 330 3330 1 15 SYSWRK WR RPASS WPASS
    MDISK 331 3330 16 20 SYSWRK WR RPASS WPASS
```

where:

The USER statement defines the userid as TESTSYS, the password as PASSWORD, and 512K storage (the minimum amount of storage to load a virtual VM/370 system).

The OPTION statement specifies the ECMODE and REALTIMER options, which are required for the virtual machine to operate in extended control mode and to wait for a timer interruption to continue processing.

The CONSOLE and SPOOL statements specify the console and spool device addresses. These addresses must match the same addresses as the real machine configuration. If that configuration is not used for the virtual system operation, they must match whatever configuration is specified in the DMKRIO module.

The LINK statement specifies that this virtual machine may operate CMS, although special considerations described later in this section have to be used to operate CMS.

The MDISK statements for 330 and 331 define disks for the CP system residence, paging, and spooling volumes.

Note: This directory entry configuration does not define any other user disks, teleprocessing lines, or tape drives. All additional devices required for testing VM/370 in a virtual machine can be specified by using the ATTACH, LINK, and DEFINE commands.

Virtual Machine Configuration

To run the VM/370 nucleus in a virtual machine, load it onto the minidisk that represents the virtual system residence volume. Then, before initializing the system, verify that the virtual machine configuration has:

- The correct console address
- Sufficient unit record devices available at the correct addresses
- Enough disks (either linked or attached) to make a reasonable test

When setting up the virtual machine configuration, a user can link to other user disks so that the VM/370 system can use these disks in its virtual operation. However, the user must ensure that links to other disks use the correct addresses and device types.

For example: A real VM/370 system has 2314s defined as 130 to 137 and has 3330s defined as 330 to 337. To avoid operational errors, the virtual VM/370 system links to user 2314 disks in the range of 130 to 137 and links to user 3330 disks in the range of 330 to 337. If a user disk is linked to as a 2314 address when it is actually a 3330 or 3340 device, the virtual VM/370 system receives errors when trying to process that user disk.

DEFINING A CONSOLE FOR VM/370 IN A VIRTUAL MACHINE

Since the logon console for a virtual machine operates as a 3215, 3210, or 1052, one of the following two methods can be used to satisfy the console requirements for your VM/370 virtual machine:

1. In the DMKRIO for the second level VM/370 system you are building, define the console device as DEVTYPE 3215, 3210, or 1052 in the RDEVICE macro (Ex: RDEVICE ADDRESS=01F, DEVTYPE=3215).

2. Another approach is attaching a console-type device to your virtual machine and using that as your second level VM/370 console. For example, if your DMKRIO for address 01F defines a DEVTYPE of 3277, then attach or DIAL a real 3277 to your virtual machine as address 01F to function as your second level VM/370 console.

Note: Regardless of which method you choose, you must specify 3215 in the CONSOLE directory statement when defining your virtual VM/370 operator.

CMS SYSTEM

For VM/370 in a virtual machine to also run CMS, it must have access to the CMS system residence volume. The virtual machine can access this volume either before logon (by using the LINK statement in the directory entry) or after logon (by using the CP LINK command). If passwords are provided, the virtual VM/370 system can link to other users' disks so that they can be used as primary disks by the CMS system. Thus, under the one userid for the virtual VM/370 system, this system can access all the disks necessary to do a virtual system VMFLOAD or any other similar function.

2305 DEVICES

It is probably not necessary to have a 2305 paging device in the configuration unless the test specifically addresses that device. If this device is required and if the real configuration allows it, the user may define temporary 2305 space for a paging volume. Depending upon the nature of virtual machine testing, one or more teleprocessing lines can be defined so that users may use the DIAL command to access the VM/370 system in a virtual machine. In most cases, simple tests do not require teleprocessing lines to be defined or enabled at the virtual machine level. Most testing can be performed by the operator's virtual machine from the virtual console.

CP DISKS FOR THE VIRTUAL MACHINE

Before VM/370 in a virtual machine can use the CP disks for the virtual system residence, paging, and spooling volumes, an installation must first format and allocate space for these disks.

Formatting the Volumes

To format the system residence, paging, and spooling volumes, use the CP format/allocate program. Although this program can run in a virtual machine, it cannot run under CMS. To run the format program, make it available to the virtual machine by reading it into the virtual machine's spool card reader. Then, IPL it from that reader. Because a virtual disk is being formatted, the cylinder specification should reflect the size of the virtual disk being used. For example: In the sample directory entry for TESTSYS (described earlier in this section), the MDISK statement for the virtual disk at real address 330 defines only 15 cylinders for the device; thus, only 15 cylinders on the virtual disk at real address 330 can be formatted.

When the virtual machine is going to use the same DMKSYS module that the installation is using, the virtual disk label should match the label in the installation-owned list. Thus, if an installation has two volumes in the owned list (such as CPDSK1 and CPDSK3), then those volume labels must match the minidisk labels used by the virtual machine.

Allocating Space for the Volumes

After formatting the volumes, allocate space on them to hold:

- A virtual directory
- Nucleus cylinders
- Warm start cylinders
- Error recording cylinders
- Temporary space for paging and spooling

If the space is inaccessible to the virtual VM/370 system (that is, beyond the size of the virtual disk), it must be assigned as permanent space. Otherwise, the virtual system attempts to access temporary space beyond the size of the virtual disk, resulting in the real VM/370 system reflecting seek checks to the virtual system.

When allocating permanent space, organize the cylinders to hold the directory, CP nucleus, error recording area, and the warm start cylinders. Also, organize the cylinders to begin with the first cylinder available on the disk. If the real system residence volume uses this same organization, the disk you use for your virtual system residence volume can use the same DMKSYS and DMKRIO modules.

For example: If the real configuration specifies permanent space, then the installation must generate a special DMKSYS module for the VM/370 system in a virtual machine. When operating in a virtual machine, it is preferable that the same installation modules be used. Using the same modules ensures that the testing environment matches the modules used in the real machine configuration. The only exception to this rule is the directory that appears on the virtual disk. The directory on the virtual disk cannot be the same as the real system directory because none of the labels and displacements for the user disks match.

To create the virtual directory for the virtual system residence volume, run CMS in the same virtual machine. First, set up a CMS file on one of the virtual disks. Second, have the virtual VM/370 user link to the CMS file with the desired filename and the filetype of DIRECT. The DIRECT program that is given control under CMS uses this file to create the virtual system's directory.

Note: The DIRECT file must contain sufficient directory entries to test VM/370 in a virtual machine environment.

Virtual IPL and Operation

Once a user has verified (by using a QUERY VIRTUAL command) that the virtual machine configuration matches the one that he wishes to test, he can perform a virtual IPL of the virtual disk containing the CP nucleus. (In the example used at the beginning of this section, it is disk 330.) Because a terminal is handled like a simulated virtual console, (this example uses a 2741 terminal), each exclamation point (!) appearing in the sample terminal output indicates that the attention key has been pressed. The operation of the attention (ATTN) key on the terminal remains the same as it would have been if running any other system, but the operation of the virtual console is as though the device were an online console (3215) and not a 2741.

Note: Attention handling varies with the type of terminal used. Refer to the VM/370 Terminal User's Guide for a list of the terminals supported by VM/370.

Proceed through the virtual machine IPL in the normal fashion, responding where required. Because the virtual VM/370 user cannot set the time-of-day clock, always reply "no" to the change time-of-day clock question. Under most circumstances, it is advisable to perform a cold start unless some specific function requiring a warm start is to be tested. When the test system has read/write access to a CMS minidisk, it can use the IPCS component of VM/370 to process any dumps taken of the virtual CP system. By using IPCS in the test system, an installation can standardize its VM/370 problem reporting and tracking process.

To place dumps of the virtual CP system in the test system's virtual reader:

1. Specify the test system's userid in the SYSDUMP operand of the SYSOPR system generation macro instruction.

2. Initialize the virtual CP system by assuming the SET DUMP AUTO CP command (class B) by default.

Note: The test system's userid in the SYSDUMP operand should be OPERATOR, rather than the default of OPERATNS. OPERATOR helps the user to readily identify his dumps. It also makes the dump immediately available to the OPERATOR virtual machine user for IPCS processing.

Once the user IPLs the virtual machine and logs on the operator's virtual machine, he can operate virtual operating systems under this userid or enable virtual teleprocessing lines. Enabling these lines allows other users to dial into this system, log on to VM/370 in a virtual machine, and perform whatever actions they require.

ACCESSING DEVICES

Once a user IPLs the virtual machine, the devices that were not accessible to that machine at IPL time are considered offline. However, the user can attach more devices to this machine and have them placed online as required. For example: Tape drives can be attached by the real machine operator to the virtual machine configuration at the required address that matches the configuration of the virtual CP system. The same procedure can be used for teleprocessing lines, unit record equipment, or other devices.

Note: Most testing can be done by initializing and running tests from the operator's virtual machine without enabling any virtual teleprocessing lines.

Teleprocessing Lines and Spool Devices

Teleprocessing lines and spool unit record devices can be created by using the CP DEFINE command. Before the virtual CP operator can attach these lines or devices to a virtual machine user, they must first be placed online at the virtual machine level. Once online, they can be attached and used by virtual machines in the virtual CP system. (Teleprocessing lines can be attached directly to the virtual CP system for testing in that environment without using the CP DIAL command.)

Virtual Disks

It is possible to use virtual disks in the virtual CP system; however, their setup is complex and requires careful coordination with the real directory of the real system. For example: If a virtual disk is moved and the real directory of the real system is changed but the virtual directory is not changed, serious operating errors can occur; therefore, do not use virtual disks in the virtual CP system unless they are required for a specific test.

Note: When a virtual machine is linked to virtual disks before the user IPLs a system to run in the virtual machine, the virtual disks appear to the virtual system as disks with a zero cylinder relocation factor; that is, for CMS to access them at the virtual CP level, attach the disks at the CP level. Then the user can access them as though they were dedicated disks. Otherwise, accesses beyond this disk cause the real CP system to present I/O errors in the form of seek checks to the virtual CP system, which, in turn, reflects the errors to the virtual operating system.

SPOOLING CONSIDERATIONS

If the virtual machine performs any spooling operations, the virtual CP system is also spooling unless it has dedicated unit record devices. This double spooling operation is not a problem; however, certain operational peculiarities exist. For example: When the virtual system specifies that a printer is producing output, the output is in fact being spooled. However, the user cannot easily determine when this spooling operation is complete. One way to make this determination is to specify a CP DRAIN command on the particular output device. When the virtual CP system reports that the device is drained, the output has indeed stopped.

To see the real spooled output, specify a CP CLOSE command for that device to the real CP system. Also, note that double separators occur. For instance, the separator page on virtual printed output includes four pages (two pages for the virtual CP system and two more pages for the separator of the virtual machine on which the virtual CP system is running). The extra set of separator pages can be avoided by using the START command with the NOSEP option.

Because the virtual machine operation at this level is complex, there is no easy way of describing how to do all the functions. It requires careful study and analysis. At all times it requires an awareness of at what level of virtual machine is operating and what function the user is trying to perform.

Example -- Running VM/370 Under VM/370

The following sample terminal session illustrates how to run a virtual CP system in a virtual machine environment. It is annotated to point out some of the more pertinent considerations.

```
vm/370 online     ljh359 qsyosu

logon v145r
ENTER PASSWORD:

LOGMSG - 17:20:14 EDT THURSDAY mm/dd/yy
* RUNNING SYS061--IPL 7
* QUERY LOG FOR RESTRICTIONS
LOGON AT 18:38:06 EDT THURSDAY mm/dd/yy
```

This segment shows a normal logon procedure for a user identified as V145R. This userid is defined in the real CP directory with sufficient options and configurations to run VM/370 in a virtual machine environment.

```
query virtual
STORAGE = 00512K
RDR  00C CLS A
PUN  00D CLS A          COPY 01
PRT  00E CLS A          COPY 01
CONS 01F ON DEV 051
DASD 190 2314 CMS370 R/O 056 CYL
DASD 19A 2314 CMS190 R/O 055 CYL
DASD 19E 2314 CMS190 R/O 026 CYL
DASD 290 2314 PIDSK3 R/O 045 CYL
DASD 330 3330 PIDSK4 R/W 020 CYL
```

After logon, issuing the QUERY VIRTUAL command permits a user to verify the virtual machine configuration. The response indicates:

- The storage size is 512K bytes.
- Some unit record devices have been defined.

- The console is 01F and is real device 051.
- Devices 190, 19A, and 19E are used to operate CMS in this virtual machine.
- Device 290 is not used and could have been deleted.
- Device 330 is the 3330, 20-cylinder, read/write minidisk that becomes the virtual system residence volume for this virtual system when it is running VM/370.
- The volume serial numbers (volids) for the DASD devices are those of the real disks on the real computing system.

```
link usecms 191 191 rr
ENTER READ PASSWORD:

DASD 191 LINKED R/O; R/W BY USECMS
```

The LINK command allows the user to access a userid that has a CMS disk containing certain directory files. This example uses one of these files to create a virtual system directory.

```
def 1f as 009
CONS 009 DEFINED
i cms
CMS...FLOOR...mm/dd/yy

Y (19E) R/O.
A (191) R/O.
013 USERS, 000 DIALED
DMSACC113S 'B (196) ' NOT ATTACHED.
DMSACC113S 'C (194) ' NOT ATTACHED.
R;
```

This segment shows the redefinition of console 01F as 009 before issuing the CP IPL command. The error messages indicate that a PROFILE EXEC is running from the user's 191 disk; the PROFILE EXEC is attempting to access disks that are not defined in the virtual machine configuration. However, these disks are not required to do a directory load.

```
listf * direct a
FILENAME FILETYPE MODE
V145A    DIRECT   A1
USERTEST DIRECT   A2
USER     DIRECT   A1
USER1    DIRECT   A1
R;
```

This LISTFILE command, issued in the CMS environment, shows that there are four files with a filetype of DIRECT. This example uses the one named V145A.

```
type v145a direct

DIRECTORY 330 3330 CPDSK3
    USER OPERATOR OPERATOR 256K 1M ABCDEFG
    ACCOUNT 12345678 COMP.RM
         CONSOLE 9 3215
         SPOOL C 2540 READER A
         SPOOL D 2540 PUNCH A
         SPOOL E 1403 A
         LINK USECMS 191 191 WR
         MDISK 196 3330 0 10 SYS196 RR RDGDEV
         MDISK 190 2314 0 56 CMS190 RR RDGDEV
         MDISK 19E 2314 0 26 FLRCMS RR RDGDEV
    USER USECMS TOM 256K 1M G
    ACCOUNT 12345679 ROOM331
         CONSOLE 9 3215
         SPOOL C 2540 READER A
         SPOOL D 2540 PUNCH A
         SPOOL E 1403 A
         LINK OPERATOR 196 196 RR
         LINK OPERATOR 190 190 RR
         LINK OPERATOR 19E 19E RR
         MDISK 191 3330 0 9 USECMS WR RDGDEV WDGDEV MDGDEV
         MDISK 192 2314 T-DISK 5
         DED 19A CMS19A
R;
```

This segment requests a typed copy of file V145A DIRECT. The DIRECTORY statement specifies that the directory is to be written on a 3330 device at address 330 and that its virtual label is CPDSK3. This address corresponds to the 3330 virtual disk that was shown and discussed under the QUERY VIRTUAL command at the beginning of this example. Because this is a virtual disk, CPDSK3 is a virtual label, not a real label. Thus, the virtual 3330 disk (CPDSK3) is on the real disk labeled PIDSK4. This virtual disk was previously formatted, labeled, and allocated by the CP format/allocate program (not shown in this example).

Note: The user identified as OPERATOR has all privilege classes to easily control the virtual VM/370 system. The console and unit record devices are defined to allow him to operate CMS. The virtual disks defined for this userid have a displacement of zero and a size that does not exceed the bounds of the virtual disks defined for the virtual VM/370 system. The volids specified on the directory statements are the volids on the virtual disks for the virtual CP system. They are not the volids of the real disks on which those virtual disks are defined for the virtual CP system.

```
direct v145a
EOJ DIRECTORY UPDATED
R(00006);
```

This segment shows the operation of the directory program in a virtual machine. The file used to create the virtual directory is V145A DIRECT, which was previously typed out. Note that the return code is 6. The directory has been updated on the disk, but because this disk is a virtual disk and not the real system residence disk, the real CP system directory has not been modified. The return code of 6 is the normal code indicating this fact. However, a return code of 4, 5, or 6 is acceptable.

```
det 191
DASD 191 DETACHED
R;
```

Since the 191 disk of user USECMS is no longer needed, it is now detached.

```
link cpsys 196 196 rr
ENTER READ PASSWORD:

R;

link cpsys 194 194 rr
ENTER READ PASSWORD:

R;

acc 196 a
'196' REPLACES ' A (191) '.
A (196) R/O.
R;

acc 194 b/a
B (194) R/O.
R;
```

Before doing a virtual VMFLOAD function, it is necessary to access the disks required to perform this function. The LINK commands define the disks that contain the CP system to be tested in a virtual machine environment. The CMS ACCESS commands access those disks and place them in a read-only status.

```
spool pun *
R;
```

The CP SPOOL command transfers the output of the spool punch back to this userid. This is required so that the user may later IPL the virtual card reader to load the CP nucleus onto the virtual system residence disk.

```
spool prt *
R;
```

The CP SPOOL command transfers the output of the printer back to this userid. This transfer is required so that the user may later read in the nucleus load map used by IPCS for creating problem reports.

```
vmfload cpload ptmx
**********SYSTEM LOAD DECK COMPLETE
PCH FILE 0189 TO V145R
R;
```

The VMFLOAD function is executed specifying the load list of CPLOAD and a control file of PTMX. PTMX is a special control file used to apply experimental updates and PTFs. The series of asterisks are the CMS blip character, which CMS types or displays whenever the virtual machine uses two seconds of processor time. At the completion of the load function, the spool file is transferred to V145R and is available as a reader file.

```
!!
CP
ipl 00c
NUCLEUS LOADED ON CPDSK3
DMKDSP450W CP ENTERED; DISABLED WAIT PSW
CP
```

The user is now finished using CMS for the directory and IPL deck setup. The IPL of card reader 00C loads the nucleus, and the loader is distributed with the following default I/O addresses:

```
CONSOLE = 009
PRINTER = 00E
```

```
close prt
PRT FILE 0190 TO V145R COPY 01 NOHOLD
```

The CLOSE command causes VM/370 to place the nucleus load map in the virtual reader. The following message indicates that this nucleus has been loaded on the virtual disk.

```
NUCLEUS LOADED ON CPDSK3
```

The virtual minidisk label must either be CPDSK3 or be defined in the DMKSYS module. The virtual machine enters the disabled wait state after producing a message from the real CP system.

```
def 009 as 01f

CONS 01F DEFINED
```

The console must be redefined as 01F. This is the console address that was specified in DMKRIO which was loaded as part of the CP nucleus.

```
i cms
CMS . . . FLOOR . . . mm/dd/yy

Y (19E) R/O
R;
read testnuc map
RECORD LENGTH IS '132' BYTES
R;
```

Initializing CMS and reading TESTNUC MAP places the nucleus load map on the test userid's CMS A-disk. By saving the load map on this disk, the test system at the virtual CP level can use IPCS to access it and create problem reports.

```
query virtual
STORAGE = 00512K
RDR  00C CLS A
PUN  00D CLS A        TO V145R
PRT  00E CLS A             COPY 01
CONS 01F ON DEV 051
DASD 190 2314 CMS370 R/O 056 CYL
DASD 191 2314 PIDSK3 R/W 010 CYL
DASD 194 3330 PIDSK5 R/O 060 CYL
DASD 196 3330 PIDSK7 R/O 010 CYL
DASD 19A 2314 CMS190 R/O 055 CYL
DASD 19E 2314 CMS190 R/O 026 CYL
DASD 290 2314 PIDSK3 R/O 045 CYL
DASD 330 3330 PIDSK4 R/W 020 CYL
```

The QUERY VIRTUAL command displays the current virtual machine configuration. This is the configuration that was used to run the CMS machine, except that the console address has been changed to 01F. Before initializing the virtual 330 disk and bringing in VM/370, it is necessary to redefine the disk addresses so that they can be recognized by the VM/370 system.

```
define 190 as 130
DASD 130 DEFINED
define 194 as 331
DASD 331 DEFINED
define 196 as 332
DASD 332 DEFINED
define 19e as 131
DASD 131 DEFINED
link virtest 191 333 r
ENTER READ PASSWORD:

DASD 333 LINKED R/O
```

These DEFINE commands and the LINK command change the configuration of the virtual machine so that it can be recognized by the virtual VM/370 nucleus. Note that the 2314s are defined in the 2314 range of 130 to 137 and that the 3330s are defined in the 3330 range of 330 to 337. The LINK command is used to access another user's disk as a 3330 at address 333.

```
query virtual
STORAGE = 00512K
RDR  00C CLS A
PUN  00D CLS A       TO V145R
PRT  00E CLS A             COPY 01
CONS 01F ON DEV 051
DASD 130 2314 CMS370 R/O 056 CYL
DASD 131 2314 CMS190 R/O 026 CYL
DASD 19A 2314 CMS190 R/O 055 CYL
DASD 290 2314 PIDSK3 R/O 045 CYL
DASD 330 3330 PIDSK4 R/W 020 CYL
DASD 331 3330 PIDSK5 R/O 060 CYL
DASD 332 3330 PIDSK7 R/O 010 CYL
DASD 333 3330 PIDSK7 R/O 010 CYL
```

A CP QUERY VIRTUAL command is issued again to show that the virtual machine configuration has been redefined to match the one that can be recognized by the virtual VM/370 system. Notice that the 330 disk has read/write status (this is required for VM/370 to do virtual paging and spooling). All the other disks have read-only status. Disks 19A and 290 are not recognized by the virtual VM/370 system because they are not defined in the DMKRIO module; however, their inclusion in the configuration does not matter.

```
ipl 330
```

The virtual VM/370 system is loaded by an IPL of the virtual system residence volume (330).

```
VM/370 VERSION x LEVEL 1 PLC nnn mm/dd/yy hh:mm:ss

NOW 19:02:54 EDT THURSDAY mm/dd/yy
CHANGE TOD CLOCK (YES|NO) :no
19:03:15 DMKLNK018E USECMS 191 NOT LINKED; VOLID USECMS  NOT MOUNTED
RRRR....RING....GGGG
19:03:16 DMKLNK108E OPERATOR 19E NOT LINKED; VOLID FLRCMS NOT MOUNTED
RRRR....RING....GGGG
19:03:16 LOGON AT 19:03:16 EDT THURSDAY mm/dd/yy
19:03:16 LINE 01F LOGON  AS OPERATOR USERS = 001
19:03:16
```

This output is from the VM/370 system running in a virtual machine. It is printing the responses on what appears to it as a virtual 3215 console. Note that the CHANGE TOD CLOCK (YES/NO) prompting message does not require a response. If the response had been yes, it would have requested a date and time to be set; however, the real time-of-day clock cannot be changed from a virtual machine environment. The LINK error messages are a result of the automatic operator logon and of the directory not being able to find some disks defined in the operator's virtual machine. The "RING" message is the real CP simulation of the virtual console alarm function. Finally, the operator receives confirmation of a logon.

```
DMKCPI951I CP VOLID CPDRM1 NOT MOUNTED

RRRR....RING....GGGG
19:03:16

DMKCPI951I CP VOLID PIDSK2 NOT MOUNTED

RRRR....RING....GGGG
19:03:16 START ((COLD|WARM) (DRAIN))|(SHUTDOWN) :cold
19:04:00 FILES:  NO RDR,  NO PRT,  NO PUN
```

VM/370 issues the messages indicating that CPDRM1 and PIDSK2 are not mounted because the virtual DMKSYS module has an owned list that has three volumes specified: CPDRM1, PIDSK2, and PIDSK3. The only one available in the configuration during IPL was the system residence volume, CPDSK3. These error messages are not severe: only a minimum amount of space is required by CP to accomplish paging and spooling. The response to the start message in this case is "cold," which should be the normal response unless a specific test of warm start is required.

```
!
19:04:23 query dasd all
19:04:30 DASD 130 CP SYSTEM CMS190    001
19:04:30 DASD 131 FREE
19:04:30 DASD 132 OFFLINE
19:04:30 DASD 133 OFFLINE
19:04:30 DASD 134 OFFLINE
19:04:30 DASD 135 OFFLINE
19:04:30 DASD 136 OFFLINE
19:04:30 DASD 137 OFFLINE
19:04:30 DASD 250 OFFLINE
19:04:30 DASD 251 OFFLINE
19:04:30 DASD 252 OFFLINE
19:04:30 DASD 253 OFFLINE
19:04:30 DASD 254 OFFLINE
19:04:30 DASD 255 OFFLINE
19:04:30 DASD 256 OFFLINE
19:04:30 DASD 257 OFFLINE
19:04:30 DASD 2D0 OFFLINE
19:04:30 DASD 2D1 OFFLINE
19:04:30 DASD 2D2 OFFLINE
19:04:30 DASD 330 CP OWNED  PIDSK4    001
19:04:30 DASD 331 CP SYSTEM CPRL10    001
19:04:30 DASD 332 CP SYSTEM SYS196    001
19:04:30 DASD 333 FREE
19:04:30 DASD 334 OFFLINE
19:04:30 DASD 335 OFFLINE
19:04:30 DASD 336 OFFLINE
19:04:30 DASD 337 OFFLINE
19:04:30 DASD 350 OFFLINE
19:04:30 DASD 351 OFFLINE
19:04:30 DASD 352 OFFLINE
19:04:30 DASD 353 OFFLINE
```

In this example: The exclamation mark (!) indicates that an attention has been signaled. VM/370 reflects this signal as an attention to the virtual machine. The virtual CP system responds to the attention by typing the time and issuing a read. The response to the read is the entry of the QUERY DASD command. The response to this command from the virtual CP system is the DASD status shown. Notice that most of the devices are in an offline condition, since at the time of the IPL these device addresses were not available in the virtual machine configuration. The devices that were available are now marked free, owned, or system. (The system volumes are ones that have minidisks in use by the operator.) Notice that device 332 has a label of SYS196 in the virtual CP system. A previous QUERY VIRTUAL showed that DASD 332 is actually physically mounted on PIDSK7. However, this label is the real system label and is not the one recognized by the virtual CP system. For users to access the 332 disk, the virtual directory must refer to the virtual label of SYS196. (The operator's virtual disk 196 refers to a zero cylinder displacement on volume SYS196.)

```
!
19:06:34 q virtual
19:06:40 STORAGE = 00256K
19:06:40 CONS 009 ON DEV 01F
19:06:40 RDR  00C CLS A
19:06:40 PUN  00D CLS A          COPY 01
19:06:40 PRT  00E CLS A          COPY 01
19:06:40 DASD 190 2314 CMS190 R/O 056 CYL
19:06:40 DASD 196 3330 SYS196 R/O 010 CYL
```

Again, the user signals attention to the virtual CP system. The operator types in QUERY VIRTUAL, and the display is the virtual machine configuration for the virtual machine operator. Note that the operator has a configuration that is suitable for running CMS by loading (via IPL) virtual device 190.

```
19:07:38 att 131 operator 191
19:07:55 DASD 131 ATTACH TO OPERATOR 191
```

The operator attaches what appears to him as real disk 131 to himself as virtual address 191. The response indicates a successful attach.

```
!!
CP
q v 131
DASD 131 2314 CMS190 R/O 026 CYL
```

The attention signalled here, shown by two exclamation marks followed by the word CP, indicates that the user is at the real CP level. At that level, issue a QUERY VIRTUAL 131. The response indicates that the virtual 131 disk is a 2314 with read-only status, with 26 usable cylinders.

```
!
19:08:40 q 131
19:08:50 DASD 131 ATTACH TO OPERATOR 191
!
19:08:58 q v 191
19:09:04 DASD 191 ON DEV 131
```

Signalling attention takes the user back to the virtual machine level, where an attention interrupt is reflected. The virtual CP system then responds with the time and issues a read. At the virtual CP system level, the user issues a QUERY 131, which for the operator is a query of what appears to him as real disk 131. Note that the status is that of the disk attached to the operator as virtual address 191. This is the same disk that was previously noted; however, the virtual CP system thinks that the disk has read/write status. The single attention again causes a read, and the user issues a QUERY VIRTUAL 191. The response indicates a dedicated disk on device 131 and assumed read/write status.

```
!
19:09:16 ipl 190
19:09:23 CMS..FLOOR..mm/dd/yy

DMSACC112S 'A (191) ' DEVICE ERROR
R; T=0.02/0.04 19:11:29
```

Signalling attention again causes a CP read, and the operator performs a virtual IPL of the virtual 190 disk to load the CMS system. The response is from the CMS system running in a virtual machine under a virtual VM/370 system running under a real VM/370 system. A carriage return to the ensuing read gives an error message from CMS. The error message appears because CMS has an indication from the virtual CP system that it has write access to the disk (since it appears as a dedicated disk). However, the real CP system has the disk in read-only status and rejects the write attempt to the virtual CP system, which in turn reflects it tc CMS, causing the device error message.

```
!!
CP
det 333
DASD 333 DETACHED
link virtest 191 333 w
ENTER WRITE PASSWORD:

DASD 333 LINKED R/W
```

The user then enters the real CP mode by signalling attention. The user detaches device 333 and links to it as 333 in write mode. The fact that the operator detached and relinked is transparent to the virtual CP system at this level. The user has accomplished a status change from read to write. The physical extent definition has not changed.

```
!
19:15:38 det 191#att 333 operator 191
19:15:52 DASD 131 DETACHED OPERATOR 191
19:15:52 DASD 191 DETACHED
19:15:43 DASD 333 ATTACH TO OPERATOR 191
19:15:53 b
CMS

acc 191 a
R; T=0.39/0.76 19:16:23
```

Signalling attention causes a read from the virtual CP system, where the operator detaches the virtual 191 disk and attaches the real 333 disk to his userid as 191. Note that the 333 appears to the virtual CP system as a real disk, when it actually is a virtual disk. The BEGIN command changes the virtual machine environment to CMS. The ACCESS 191 command is then successfully completed, giving write access to the virtual 191 disk, which is the virtual CP system's 333 disk previously linked in write mode.

```
print profile exec
19:16:45 PRT  00E OUTPUT OF OPERATOR FILE  = 0002 LINES= 00013
R; T=0.23/0.51 19:16:46

!
19:17:05 drain 00e
19:17:04 PRT  00E SPOOL CLS XA  DRAINED
```

From CMS, the PROFILE EXEC is printed. The virtual CP system responds with a printer output message for file 2, which is the output from the previous print function. The ready message is the response from the CMS system. This example shows a virtual machine running with a virtual console that is receiving both virtual machine and CP messages. Signaling attention places the virtual machine in virtual CP mode, where the user can specify a drain of device 00E. The system responds with a message indicating that the device is drained. This indicates that the virtual CP system has completed printing on what it thinks is a real printer. This printer is actually spooled by the real CP system.

```
!!
CP
close 00e
b
CMS
```

Signalling attention returns the user to the real CP system level, where he issues a CLOSE 00E command, followed by a BEGIN. This allows him to have the spooled output of the virtual VM/370 system printed on the real VM/370 system printer.

```
!
19:19:44 set dump auto CP
!
19:19:51 q dump
19:19:55 DASD  330 DUMP UNIT CP
```

Signalling attention takes the user to the virtual CP level, where he issues a SET DUMP command. Ordinarily, when testing an unstable system, this would have been one of the first commands entered after issuing the IPL for the virtual CP system. The query of the dump unit verifies that the dump is of the CP nucleus to the spooling disk at address 330.

```
!!
CP
system restart
RRRR....RING....GGGG

19:20:06 DMKDMP908I SYSTEM FAILURE; CODE PSA002

RRRR....RING....GGGG

RRRR....RING....GGGG

DMKCKP960I SYSTEM WARM START DATA SAVED

DMKDSP450W CP ENTERED; DISABLED WAIT PSW
CP

DMKCKP961W SYSTEM SHUTDOWN COMPLETE

CP

RRRR....RING....GGGG
CP
```

Signalling attention takes the user to the real CP level, where he enters the command SYSTEM RESTART. This command is the equivalent of a system restart function on a real processor. The system restart function for a CP system automatically dumps the system and then issues IPL again. After the system is dumped, a message appears with abnormal termination code PSA002 (a system dump due to pressing the system restart key).

The virtual bell rings to indicate that the system has been reloaded, and the system prints messages about: saving warm start data, CP entering a disabled wait state, and system shutdown being complete. The message indicating that CP has entered a disabled wait state is prematurely issued between these two messages. It occurs because of a synchronization of the real CP system with the virtual CP system console output.

After these messages are issued, the user is in real CP mode. He can either log off or obtain the system abend dump.

To obtain this dump, re-IPL 330 and repeat the test procedure up to the point where the 'print profile exec' is shown in the same session. At this point, the user now has CMS initialized in the virtual CP system and has read/write access to his real CMS minidisk at virtual address 191. By issuing a QUERY RDR ALL command, VM/370 should reveal that a class D dump file is in the operator's virtual reader (because the operator's userid is specified in the SYSDUMP operand of the SYSOPR system generation macro instruction).

```
!
19:22:10  spool rdr cl d
19:22:10  b
CMS
vmfdump
.
.
.
R;
```

The SPOOL RDR CL D command allows the virtual reader to access the class D dump file. By entering the B (BEGIN) command, the virtual machine user returns to CMS. By entering the VMFDUMP command (class C or E), IPCS reads the CP abend dump and creates a CMS dump file, problem report, and symptom summary entry on the 191 A-disk. (For a sample VMFDUMP session, refer to VM/370 IPCS User's Guide.)

When VMFDUMP processing completes under CMS in the virtual CP system, terminate the test system by entering real CP mode and initializing CMS. Under CMS, the user can issue the IPCS DUMPSCAN command to look at the dump taken cf his virtual test system. This dump resides as a dump file on the user's real 191 A-disk.

Summary

Tc update and test a VM/370 system in a virtual machine, an installation must first have a VM/370 directory entry for a VM/370 virtual machine. This virtual directory entry need only specify the minimum number of users sufficient to perform the test. Before initializing this system, an installaticn should verify that the virtual machine configuration has: the ccrrect console address, sufficient unit record devices available at the correct addresses, and enough disks (either linked or attached) tc make a reasonable test. Also, the VM/370 virtual machine can run CMS when it has access to the CMS system residence volume.

With few exceptions, IPL for a VM/370 virtual machine is similar to IPL for a real VM/370 system. Operationally, VM/370 provides CP ccmmands to display and store into real storage. The VM/370 system in a virtual machine can also display and store into its own third level virtual storage. If the virtual machine performs any spooling operations, the virtual VM/370 system is also spooling unless it has dedicated unit record devices. This double spooling is no problem; hcwever, there are some special operational considerations.

Section 3. DOS/VS in a Virtual Machine

This section uses the term "DOS/VS" as a generic expression. It represents any or all of the DOS, DOS/VS, and DOS/VSE system control programs unless specified otherwise.

When loading DOS/VS into a virtual machine running under VM/370, the terminal becomes the DOS/VS operator console, and the user is responsible for entering all the commands and responses normally required of the operator.

The three basic techniques to use when running DOS/VS in a virtual machine are:

- Run DOS/VS in batch mode. The terminal is the operator console, and other users may submit jobs either through the real system virtual card reader or from the virtual card punches of other userids.
- Use the IPL command to alternate between using DOS/VS and CMS in a single virtual machine. Use CMS to prepare a job stream for DOS/VS, use DOS/VS to execute the job stream, and use CMS to check the output.
- Log onto a userid and load DOS/VS. Once it is running, disconnect from that userid and log onto another userid while the DOS/VS userid continues working. To check on the status of DOS/VS, disconnect from the current virtual machine and reconnect the DOS/VS virtual machine.

Before discussing these three techniques in greater detail, the user must understand how to:

- Generate DOS/VS to run in a virtual machine
- Create VM/370 directory entries for DOS/VS virtual machines
- Access the DOS/VS system residence volume
- Ensure that the proper I/O devices are attached to the DOS/VS virtual machine
- IPL and operate DOS/VS under VM/370

System Generation Recommendations

When generating DOS/VS to run in a virtual machine, an installation should have these primary objectives:

- To reduce the number of SIO instructions issued by DOS/VS, including those issued for DOS/VS paging I/O operations
- To avoid double CCW translation

To meet these objectives, an installation needs to consider how it generates both VM/370 and DOS/VS.

Note: The fcllowing recommendations have been made by users who run DOS/VS in a virtual machine under VM/370. As such, these recommendations have not been submitted to any formal IBM tests. Pricr tc any implementation, an installation should evaluate their usefulness in its own configuration.

VM/370 RECOMMENDATIONS

When generating VM/370 for a DOS/VS virtual machine, note the following recommendations:

VM/370 Saved Systems

IPL time can be reduced by saving any operating system after the generated operating system has been loaded on VM/370. For more information about generating saved systems, refer to the VM/370 System Programmer's Guide.

Handshaking for DOS/VS

DOS/VS Release 34 with the Advanced Functions-DOS/VS Program Product (Program No. 5746-XE2) uses VM/VS handshaking. The use and efficiency cf DOS/VS with handshaking is similar to using VS1 handshaking with VM/370. For further details, refer to the appropriate DOS/VS program product publications.

DOS/VSE with the VSE/Advanced Functions Program Product (5746-XE8) uses VM/VS handshaking (also known as the DOS/VSE-VM/370 linkage facility). The use and efficiency of DOS/VSE with handshaking is similar to using VS1 with handshaking. For further details, refer to VSE/Advanced Functions General Information, GC33-6106.

Initializing Disks and Minidisks

Tc initialize a DOS/VS minidisk for use under VM/370, the VM/370 IBCDASDI service program must be used. If the whole disk is used by DOS/VS, any DOS or OS disk initialization program may be used.

DOS/VS RECOMMENDATIONS

When generating DOS/VS to run in a virtual machine, note the following recommendations:

Generating a DOS/VS Supervisor

- Specifying boundary size (DOS/VS Release 34 and earlier only)
  When generating a DOS/VS supervisor, use 4K (the size of VM/370's pages) whenever DOS/VS recommends using a 2K boundary or a multiple of 2K. Thus, do not use the default for the SEND macro instruction. It causes DOS/VS to round the supervisor size to the next 2K boundary. Instead, manually calculate the size of the supervisor and specify a 4K boundary in the SEND macro instruction. This specification forces DOS/VS to be loaded at the next 4K page boundary.

- Specifying console addresses
  Specify an address of 01F in the VM/370 directory CONSOLE statement. This specification allows the DOS/VS supervisor to run on the real processor using the real console address of 01F.

  If CMS is also to be used, it uses console address 01F. In this case, specifying 01F in the CONSOLE statement allows use of this console with both DOS/VS and CMS virtual machines.

  To use more than one DOS/VS console under VM/370 or to use a 3270 display device in display operator control mode, refer to the topic "Specifying More Than One Console in a Virtual Machine" in the "General Considerations" section of this publication.

- Reducing privileged instructions
  Improve performance by reducing the number of privileged instructions that must be handled by VM/370 and virtual machine assist. Generate a tailored DOS/VS supervisor for each virtual machine and leave out any unnecessary options. Because VM/370 issues its own stand-alone seek (except for 2314 disks), do not specify seek separation in the FOPT macro instruction.

  When using DOS/VS Release 34 (or earlier) and the computer has block multiplexer channels, specify the block multiplexer option in both the PIOCS macro instruction and the VM/370 directory OPTION statement. However, this specification is unnecessary when using DOS/VSE because block multiplexer support is standard in DOS/VSE.

  Generate several tailored DOS/VS supervisors, if desired, and store them on the same DOS/VS SYSRES with different supervisor names (such as $$A$SUPn, where n is 1, 2, 3, 4, etc.).

Specifying DOS/VS Partition Sizes (DOS/VS Release 34 and earlier only)

Performance is usually better when using several virtual machines rather than using many active partitions in one virtual machine. That is, if there is a communications system, a batch system, and a test system, create a separate virtual machine for each one. However, to only run VM/370 part of the day and to minimize operational differences, one multipartition production DOS/VS machine may be preferable.

It is usually best to make the DOS/VS partition sizes, and therefore the whole DOS/VS virtual machine, large enough so that all jobs run V=R. Let VM/370 do the paging.

Rotational position sensing (RPS) cannot be used with V=R partitions. Also, avoid double CCW translation and double paging.

Set RSIZE equal to the supervisor size plus the sum of all V=R partitions, plus the SVA, plus 32K.

Note: An installation must specify ",REAL" on the DOS/VS // EXEC job control card.

Generating the Operating System

When VM/370 is the primary operating system and DOS/VS is running one or two partitions in a virtual machine, generate DOS/VS with as few options as possible, particularly when several virtual machines share the same system residence volume.

When VM/370 is not the primary operating system and DOS/VS is usually run without VM/370, generate DOS/VS to:

- Be transparent to the users of the other systems
- Have the required number of partitions

Generating POWER/VS or VSE/POWER

When DOS/VS is run under VM/370, POWER (POWER/VS for DOS/VS or VSE/POWER for DOS/VSE) should be used with the appropriate unit record devices that are dedicated to DOS/VS.

If an installation has sufficient DASD space, let both POWER and VM/370 spool. Generate POWER with only the options that suit the installation's needs, but make the I/O buffer sizes as large as possible, up to 2008 bytes. If one job step in a DOS/VS job stream abends, it is easy to use POWER to cancel the remainder of the job stream. To use only VM/370 spooling, an installation must manually cancel each job step.

Sharing the DOS/VS System Residence Volume

There are two methods of sharing a DOS/VS system residence volume:

- Have a read/write DOS/VS system residence (SYSRES) minidisk for each DOS/VS virtual machine. Then share a read-only copy of the private core image, relocatable, and source statement libraries.
- Share a read-only copy of the DOS/VS SYSRES minidisk, and have separate read/write private libraries for each virtual machine. Because only one standard label cylinder is available, all virtual machines must coordinate their use of that cylinder.

Which method is used depends upon each installation's specific situation.

Restoring the DOS/VS PID Tape

When generating DOS/VS under VM/370, an installation must restore the DOS/VS PID tape onto a full disk pack; a minidisk cannot be used. Create an operational system residence pack on a full pack, and then use CORGZ to copy the DOS/VS SYSRES to a minidisk. Make sure that ECMODE is set 'ON'.

Reducing SLD Directory Reading

In the FOPT macro instruction, specify enough second level directory (SLD) entries to reduce repetitious reading of the directory.

Use the system directory list (SDL) in the shared virtual area (SVA) for all job control, disk and tape open and close transients, and for the attention routine.

Selecting File Names for Minidisks

If minidisks are used, although permitted on DOS/VS running native, do not use the same DOS/VS file name for more than one disk. Otherwise, VM/370 may select the wrong minidisk.

Executing Programs Under DOS/VS and CMS/DOS

If a program in the DOS/VS core image library may be executed in either a DOS/VS virtual machine or under CMS/DOS, link edit the program with ACTION REL linkage editor control statement so that it uses the DOS relocating loader.

DOS/VS ACCOUNTING

Note: This topic only applies when running DOS/VS Release 34 (or earlier). It does not apply when running either DOS/VS Release 34 with the Advanced Functions-DOS/VS Program Product (5746-XE2) or DOS/VSE.

Except with processors that have ECPS: VM/370 and virtual interval timer assist, DOS/VS accounting gives inaccurate and inconsistent elapsed processor times when operating under VM/370 with virtual machine assist. This inconsistency occurs because the interval timer (located at virtual storage location X'50') used by the DOS/VS accounting routine is only updated when VM/370 gets control. Therefore, when DOS/VS accesses the interval timer data, a variable amount of time may have elapsed since VM/370 last updated the interval timer, and thus DOS/VS records an inaccurate processor time.

To attempt to minimize this inaccuracy at the cost of some additional VM/370 overhead, an installation may wish to add the following dummy DIAGNOSE instruction:

```
83000000
```

at the following locations in the DOS/VS supervisor source statements:

- In the SVC 24 routine, before the L R3,SYSTIMER statement
- In the SVC 52 routine, before the L R3,SYSTIMER statement
- In the STCLOCK routine, before the STCK CLOCK statement
- In the timer interruption handler routine, before the LM R2,R3,SYSTIMER statement
- In the job accounting initialization routine (JATIMER), before the statement that references SYSTIMER

Note: To prevent a possible specification exception to DOS/VS, ensure that general register zero contains zeros before issuing the DIAGNOSE instruction.

If VM/370 is running on a processor model that has ECPS: VM/370 (as defined in VM/370 Planning and System Generation Guide), enable virtual interval timer assist. This action lets the hardware, rather than VM/370, update the virtual interval timer. Hardware update frequency is 300 times per second and results in accurate and repeatable time measurements.

DOS RELEASE 27 IN A V=R VIRTUAL MACHINE

To avoid compromising the CP real page zero, the DOS Release 27 supervisor must be modified and reassembled to prevent DOS from reading sense information into page zero. The recommended supervisor changes are:

1. In the FOPT macro instruction, remove the label SSKADR from the SSKADR DC statement.
2. Following the SGTCON macro instruction, add the following 5-byte DC statement:

   ```
   SSKADR DC CL5
   ```

3. Assemble and link edit the DOS supervisor again.

This supervisor now works correctly in a V=R machine as well as on a virtual (or real) machine.

Generating DOS/VS Under VM/370

This topic presents the major steps in a DOS/VS system generation procedure that is performed under VM/370. This virtual machine is assumed to have a VM/370 directory entry as shown in Figure 15. The link to CMSSYS provides the user with CMS facilities. Alternate procedures to CMS are discussed wherever applicable.

The virtual machine console is assumed to be a 3270 display terminal.

```
USER DOSVSYS PASSWORD 512K
 ACCOUNT ACCTNO BIN4
 OPTION ECMODE
  CONSOLE 009 3210
  SPOOL 00C 2540 R
  SPOOL 00D 2540 P
  SPOOL 00E 1403
  LINK CMSSYS 190 190 RR
  MDISK 191 3330 50 5 UDISK3 MR
  MDISK 250 3330 0 404 DOSSYS MR
```

Figure 15. Virtual Machine for DOS/VS System Generation

In addition to the devices specified in the directory entry for user DOSVSYS, this user temporarily needs a dedicated magnetic tape unit at address 180 on which to mount the distribution tape. The attachment of the magnetic tape drive is discussed later in this topic.

BUILDING SYSTEM GENERATION JOB STREAMS

During the entire system generation process, the user supplies the virtual machine with job streams to perform the individual steps. On a stand-alone system, these job streams are usually kept in card form. Under VM/370, the CMS editor can be used to create CMS files containing these job streams. Once created, use the VM/370 spooling functions to place these job streams into the virtual machine's card reader whenever they are needed. This technique is especially helpful when the virtual console is some distance from the real reader.

To generate a tape and disk configuration, unload the IBM-supplied base system from a distribution tape to an initialized DASD volume.

Create two small CMS files. These files contain the card reader input data for the two utility programs that occupy the first two files on the distribution tape. The file assumes: (1) the user logs onto VM/370 as user DOSVSYS, and (2) the user is in the CMS environment.

The user has entered the following sequence of commands and data entry:

```
edit initload djcl                      (Establish file identification)
input                                   (Start data entry)
// job intdsk                           ---------------
// assgn syslog,x'01f',c1                     ▲
// date 12/31/75                              |
// log                                        |
// assgn syslst,x'00e',l1                     |
// assgn sysopt,x'250',d4                     |
// exec                                     Job
// uid iq                                  stream
// vtoc strtadr=(0403000),extent=(19)         |
vol1dossys                                    |
// end                                        |
// job disrst                                 |
// assgn sys005,x'250',d4                     |
// assgn sys006,x'180',t2                     |
// assgn syslst,x'00e',l1                     ▼
// exec                                 ---------------
(null line)                             (Terminates data entry)
file                                    (Writes file on disk)
```

The job stream to initialize the disk and unload the tape is now a CMS file. It is identified by a filename of INITLOAD and a filetype of DJCL.

Similarly, a user can create CMS files containing job streams that:

- Unload the IBM-supplied system to disk without initializing the disk
- Add I/O device specifications to the IBM-supplied supervisor
- Define standard labels
- Perform librarian functions
- Assemble and catalog a new supervisor
- Assemble and catalog additional I/O modules
- Back up the new system on tape or disk

COPYING DISTRIBUTION SYSTEM TO DISK

Assume that two job streams are available as CMS files:

- INITLOAD DJCL -- initialize disk at X'250' and load from tape on X'180'

- SKIPINIT DJCL -- skip first file on tape and restore tape on X'180' to disk at X'250'

When userid DOSVSYS logs onto the VM/370 system, the virtual machine has every I/O device it needs except for a magnetic tape unit. Since this device is only required during the tape-to-disk restore operation, it would be inefficient to tie it up for the entire terminal session. Instead, send the VM/370 system operator a message such as:

```
msg op pls mount dos/vs distribution tape as 180
```

The system operator mounts the appropriate tape reel on some idle tape drive, such as 183, and issues the command:

```
attach 183 to dosvsys as 180
```

The user receives an acknowledgement:

```
TAPE 180 ATTACHED
```

The user is now ready to start system generation. If he is not in the CMS envircnment, issue the command:

```
ipl cms
```

Spool the punch to the user's virtual reader:

```
cp spool punch to *
```

If the disk is to be initialized, punch out the CMS file:

```
punch initload djcl (noheader)
```

The NOHEADER option eliminates the header record normally punched out to identify a card deck.

After a PUNCH command, the user receives an acknowledgement that the file was spooled to the reader.

If the disk had already been initialized, the user would have punched out the file:

```
LOADONLY DJCL
```

Now that the job stream is in the user's virtual reader, perform an IPL from the tape by issuing the CP command:

```
cp ipl 180
```

When the system goes into a wait state, press the PA1 key (or its equivalent) to place the virtual machine in CP console mode. Issue the CP command READY 00C to ready the virtual reader. Then, issue the CP command BEGIN to return control to the system tape.

The virtual machine is now under the control of the utility programs on tape. The virtual machine should reply to all queries as if on a real machine.

When the distributed DOS/VS has been restored to disk, the user receives a RESTORE COMPLETE and an END OF JOB message; the virtual machine is then placed in a disabled wait state, and the console is put into CP mode. To now perform an IPL from address 250, use the distributed system to perform the rest of the system generation procedures.

READYING THE INTERIM SYSTEM

The IBM-supplied supervisor does not contain any I/O device specificatcns. Until generating a new supervisor with its particular I/O configuration, the user must include the appropriate ADD and ASSGN commands each time he IPLs DOS/VS.

The following job stream files can be created for use in this and other phases of system generation:

```
IPLADD   DJCL  add and assign I/O devices
STDLABEL DJCL  assign standard labels
DSERV    DJCL  display the directories
```

To start the system, assign standard labels, display the directories, and enter the following sequence of commands:

```
cp spool punch to *
punch ipladd djcl (noheader)
punch stdlabel djcl (noheader)
punch dserv djcl (noheader)
cp ipl 250 clear
```

The last ccmmand loads the DOS/VS supervisor from unit 250. When the system goes into a wait state, ready the reader as follows:

(press PA1 key or its equivalent)

then enter:

```
ready 00c
begin
```

As each job ends, press the ENTER or RETURN key (depending on the type of terminal) to start the next job.

ASSEMBLING AND LOADING A NEW SUPERVISOR

The job stream to assemble an installation tailored supervisor is another candidate for a CMS file. In addition to the storage advantage, it is easy to assemble different supervisors.

Example: When planning to assemble a supervisor, enter the supervisor macro assembly job stream in a file called ASMBLSU1 DJCL. To generate another job stream to assemble a different supervisor, IPL CMS and enter:

```
edit asmblsu1 djcl
```

This command accesses the supervisor memo file for a CMS EDIT session. Then, use the CHANGE and INPUT subcommands of EDIT to alter the supervisor macro instructions and the job name. Enter or change the SUPVR macro instruction to include ID=2; this specification identifies the new version of the supervisor as $$A$SUP2. When all the changes have been made, file the new version under its own name by issuing:

```
file asmblsu2 djcl
```

The user now has two job streams on file, the original and new supervisor. Use this procedure to generate job streams to assemble any number of supervisors.

To assemble these two supervisors, punch the appropriate job stream files to the virtual card reader. While still in the CMS environment, issue the following sequence of commands:

```
cp spool punch to *
punch ipladd djcl (noheader)
punch stdlabel djcl (noheader)
punch asmblsu1 djcl (noheader)
punch asmblsu2 djcl (noheader)
cp ipl 250 clear
```

At this point, use the CMS editor to check the program listings for errors. There is no need to print out a hard copy. Spool the printer output to the virtual reader, return to the CMS environment, create a CMS file from the reader data, and use the EDIT function to scan the listing.

Before loading DOS/VS, include this CP command in the previous sequence of commands:

```
cp spool printer to *
```

This command directs printer output to the virtual reader. (The punch is already spooled to the reader.)

When processing more than one job, keep the output of each job separate by closing the printer and/or punch at the end of each job. When the EOJ ASMBLSU1 message appears and the virtual machine stops on an ATTN 00C, close both the punch and printer files and also assign them spool filenames and filetypes by issuing the commands:

```
#cp close punch name asmblsu1 deck
#cp close printer name asmblsu1 list
```

After issuing these commands, enter a null line to start the next job. While spool files are automatically closed when issuing an IPL command, the CLOSE command can be used on the last job to name the files.

To return to the CMS environment, enter:

```
#cp ipl cms
```

Use the CMS READCARD command to generate CMS files from the reader files. Each READCARD command converts the first file in the reader to a CMS file with the filename and filetype specified in the READCARD command. That file is then deleted from the reader queue. To determine which file is first in the reader, query the reader with:

```
cp query reader all
```

The response itemizes all the files in the reader in sequence and includes such information as file identification number, printer or punch file, and filename.

If the response to the QUERY command was:

```
... 1502 ... PUN ... ASMBLSU1  DECK
... 1503 ... PRT ... ASMBLSU1  LIST
... 1541 ... PUN ... ASMBLSU2  DECK
... 1542 ... PRT ... ASMBLSU2  LIST
```

and the user then issued:

```
readcard supvsr1 text
```

CMS reads file number 1502 and creates a CMS file with a filename of SUPVSR1 and a filetype of TEXT.

However, to check the listing for errors, issue:

```
cp order reader 1503
```

This command reorders the reader queue to bring the listing file first. Then issue:

```
readcard supvsr listing
edit supvsr listing
```

to create a CMS file containing the assembly listing and to access it for the EDIT function. By using EDIT subcommands, a user can now scan the listing for errors. If there are no errors, create a CMS file, SUPVSR TEXT, from file 1502, which is now the first file in the reader queue. If there are errors, issue:

```
erase supvsr listing
```

to discard the assembly listing, and

```
cp purge reader 1502
```

to remove the corresponding assembly text deck.

Now, use the CMS editor to correct the supervisor macro instructions and pass the job stream over to DOS/VS for another assembly.

When a supervisor text deck is ready for cataloging, insert it into a LINKEDIT DJCL job stream that was created from the CMS file, ZLIB BOOKS (previously punched out). To insert the supervisor text deck, issue the following commands:

```
(from the CMS environment)
edit linkedit djcl     (access the job stream)
next                   (position current line pointer)
delete 2               (remove CATALs and BKEND entries)
locate /include        (position current line pointer)
getfile supvsr1 text   (insert supervisor text deck)
file                   (replace updated job stream)
```

The updated LINKEDIT job stream can now be passed to DOS/VS for execution. Either execute this phase interactively as on a real machine or again use the CMS editor to tailor the LINKEDIT job stream; that is, remove any unnecessary jobs and remove the PAUSE statements from the jobs that are to be run.

Note: As an option, the user can link-edit the IBM-supplied library and service routines by using the portion of the LINKEDIT file that follows the new supervisor deck.

ADDING I/O MODULES TO DOS/VS (DOS/VS RELEASE 34 AND EARLIER ONLY)

The CMS editor can help assemble and catalog any additional IOCS modules. In the CMS environment, create a job stream file containing all the IOCS macros to be assembled and ensure that each macro statement includes the SEPASMB=YES entry. The following series of commands can be entered:

```
cp spool punch to *
cp purge reader all
punch iocsmods djcl
cp spool punch hold
cp spool printer to *
cp ipl 250 clear
```

These commands send the job stream to the virtual reader, hold the punch, and spool the printer to the reader.

When the assemblies have been completed, reload CMS and examine the listings for any errors by entering this series of commands:

```
#cp ipl cms
cp spool printer off
cp spool punch nohold
readcard iocsmods listing
edit iccsmods listing
     .
     .   (use EDIT subcommands to scan listing)
     .
quit
```

If the there are errors, use the CMS editor to correct the macro entries and resubmit the job stream. If there are no errors, enter:

```
print iocsmods listing
```

to print the assembly listings.

Enter the following commands to build a job stream that catalogs the IOCS text decks to the system relocatable library:

```
cp change reader all nohold
readcard iocsmods text
edit catalrio djcl
input // job catalrlb
input // exec maint
getfile iocsmods text
input /*
input /&
file
```

FINAL HOUSEKEEPING

Once the basic system generation is complete, a number of regularly executed housekeeping procedures can be set up as job streams. Consider job streams to perform these procedures:

- Set new standard labels
- Reallocate library sizes
- Condense libraries
- Set automatic condense limits
- Copy the system residence pack (and private libraries) for backup
- Catalog often-used job control statements and linkage editor control statements to the procedure library

To initially create job streams and pass them to DOS/VS for testing, follow the same procedures as for system generation. After verifying the job streams, use one job stream to catalog the other procedures to the system's procedure library.

Note: When cataloging job control statements to the procedure library, an installation can use the CMS editor.

Sample DOS/VS Directory Entries

The following directory entries represent some batch type virtual machines that can be used to run production jobs under DOS and DOS/VS. The operands specified on the OPTION control statement reflect the requirements of the particular system being used. Disk space can either be dedicated or shared with other systems.

A DOS Virtual Machine

```
USER DOSUSER PASSWORD 256K
     ACCOUNT ACCTNO BIN3
     IPL 350
     OPTION ACCT
          CONSOLE 01F 3215
          SPOOL 00B 2501
          SPOOL 00C 2540 R
          SPOOL 00D 2540 P
          SPOOL 00E 1403
          MDISK 350 3330 101 30 OSDOS1 W
          MDISK 351 3330 1 20 UDISK1 W
```

A DOS/VS Virtual Machine

```
USER DOSVUSER PASSWORD 512K
     ACCOUNT ACCTNO BIN4
     IPL 350
     OPTION ECMODE
          CONSOLE 01F 3215
          SPOOL 012 3505
          SPOOL 013 3525
          SPOOL 002 3211
          LINK VMSYS 190 190 RR
          MDISK 191 3330 11 10 UDISKA WR RPASS WPASS
          MDISK 350 3330 100 50 VOSDOS W
          MDISK 351 3330  21 30 UDISK1 W
```

Accessing DOS/VS

This topic assumes that DOS/VS for use under VM/370 has already been generated and that the system residence volume is available on a real disk or minidisk in read/write status. A user can make the system residence volume available in any one of these ways:

- Define the DOS/VS system residence as a read/write disk in the VM/370 directory entry for the userid running DOS/VS. A typical directory entry might look like the following:

  ```
  MDISK 250 3330 101 50 VDOSYS MR RPASS WPASS
  ```

- Link to the DOS/VS system residence volume using the LINK command. For example, if the DOS/VS system residence is on the 150 disk in the directory entry for the userid DOSRES, a user could enter:

  ```
  link dosres 150 250 w wpass
  ```

- Have the VM/370 system operator attach the DOS/VS system residence directly to a userid, for that user's exclusive use. When the operator (or another user with Class B command privileges) attaches the disk to one user, no one else may access the volume.

Note: All of the console logs and command examples in this section assume that a DOS/VS system residence is attached to the virtual machine at virtual address 250.

SHARING THE DOS/VS SYSTEM RESIDENCE VOLUME

If VSAM is used, only one user at a time may access the DOS/VS system residence volume in read/write status. This requirement is necessary because only one user can update the VSAM catalog and the label information cylinder. DOS/VS uses this cylinder to keep a record of volumes and files needed by programs that are running.

However, if VSAM is not used and a user wants to share the DOS/VS system residence volume, set up a read/write core image library for link-editing. Then, share the SYSRES libraries in read-only status with other users. This method is acceptable under one of these two conditions:

- Some action has been taken by the installation to provide individual standard label cylinders for each userid that accesses DOS/VS.

--or--

- Different virtual machines use different partitions. For example, one virtual machine uses BG and F4, and another virtual machine uses F1, F2, and F3.

Another method for sharing DOS/VS is for a user to have his own read/write copy of the system residence volume. Then, this user can share this volume with others in read-only status and share the private libraries with other users.

STANDARD LABEL CYLINDER

To share DOS/VS among virtual machines when unique partitions are not assigned to each virtual machine, a user must provide a unique standard label cylinder for each such virtual DOS/VS user.

When using DOS/VSE with the VSE/Advanced Functions Program Product (5746-XE8), a user can separate label information areas and use a name to access each area. While users must create these areas on the system residence volume, they don't have to (as in DOS/VS Release 34 and earlier releases):

- Place label information areas at the end of the volume, following the normal standard label cylinder
- Modify the IPL communication routines
- Bypass the $JOBCTLA procedure

For DOS/VS Release 34 (or earlier), the individual standard label cylinders should be placed at the end of the system residence volume (following the normal standard label cylinder). To support unique standard label cylinders, modify DOS/VS as follows:

- The communication region in each DOS/VS virtual machine must point to the appropriate label cylinder for each user. Do this by modifying the IPL communication routines.
- Bypass the procedure $JOBCTLA. This procedure updates the communication region pointer to the normal standard label cylinder at the end of each job.
- Bypass the label cylinder reset code in the $$BSYSWR procedure. $$BSYSWR resets the normal standard label pointer whenever a condense function (CONDS) of the MAINT program is requested. As an alternative, never condense a library in any virtual machine using a non-standard label cylinder.

Using Virtual Unit Record Devices

When using DOS/VS in a virtual machine, a user must have the following unit record devices, which are normally defined in the VM/370 directory entry:

- A virtual card reader, from which DOS/VS reads the job input stream.
- A virtual printer, which receives all the SYSLST output generated during DOS/VS operation.
- A virtual card punch, which receives SYSPCH output generated during DOS/VS operation.

Depending upon how DOS/VS was generated, a user may need to determine a virtual device address. For example: If DOS/VS expects a 3211 printer at address 002 and no printer is at this address in the virtual machine configuration, define one with the CP DEFINE command:

```
define 3211 002
```

Note: When using CMS to prepare jobs for a DOS/VS virtual machine, use the virtual card punch to spool jobs to the DOS/VS virtual machine.

Before using DOS/VS, find out (from the programmer at the installation responsible for generating and maintaining DOS/VS) what are the virtual device requirements.

A user can control virtual unit record devices with the CP SPOOL command. However, printed or punched output need not have to be printed or punched. For example: When using a technique for alternating between operating systems, a user can spool the virtual printer to the card reader, as follows:

```
spool printer to *
```

This command reads printed output onto a CMS disk so that it can be examined. Also, use the SPOOL command to change the output spooling class of the virtual machine's spooled printer or punch files.

DEFINING THE OPERATOR'S CONSOLE

During DOS/VS system generation, an address is specified for the operator's console. The user's terminal must also be at this address. Usually, DOS/VS expects the operator's console to be at real address 01F. The device has to be generated as a 3215, 3210, or 1052 console. However, when using DOS/VS in a virtual machine, any terminal type can be used as the virtual operator's console.

To find out the virtual machine's terminal address, enter this command:

```
query console
```

If the response indicates that the terminal is not at 01F but at another address, such as 009 (which is a standard VM/370 console address), enter this command:

```
define 009 as 01f
```

This command allows the terminal to now function as the operator's console for both DOS/VS and CMS.

Preparing Jobs for a DOS/VS Virtual Machine

There are several ways to prepare a job stream for a DOS/VS virtual machine:

- Prepare a deck of punched cards that contains such information as DOS/VS job control statements and input files. Place a CP ID statement at the beginning of this deck to indicate the userid of the DOS/VS virtual machine; for example:

  ```
  ID DOSVUSER
  ```

  Then put the cards in the real system card reader. Based on the userid specified on the ID card, VM/370 directs the spool file to the virtual card reader of the DOS/VS virtual machine, which in this case is being run on the userid DOSVUSER.

- Use CMS to create a disk file containing card images identical to the cards submitted in a real card reader for DOS/VS. Use the CP SPOOL command to spool the virtual card punch to the card reader of the DOS/VS virtual machine and use the CMS PUNCH command to punch the card images. In the CMS environment, issue:

  ```
  spool punch to dosvuser
  punch dosjob jcl (noheader
  ```

  Use the NOHEADER option of the PUNCH command to suppress punching a CMS READ control card at the beginning of the card deck.

A job stream spooled to DOS/VS by either of these methods remains in the card reader of the DOS/VS virtual machine until the user causes DOS/VS to begin reading the job stream from its card reader.

Spooling the card file can be done before or after initializing DOS/VS or at any time while the system is active.

Before using the virtual punch to punch jobs to a virtual machine, take the precaution of clearing any files or card images that may remain in it from previous jobs. The following commands ensure that the virtual punch does not have any other punch files in it:

```
spool punch nocont
close punch purge
```

A user should also issue these commands to purge any existing reader files of the virtual machine that run DOS/VS:

```
spool reader nocont
close reader
purge reader
```

Of course, do not purge any needed files that may be in the reader. To obtain data about existing reader files before they are purged, enter the command:

```
query reader all
```

Note: If any files are open, this command does not tell the user that they are open.

Loading DOS/VS

This topic describes one method for loading DOS/VS in a virtual machine. It shows how to enter the commands and control statements to IPL DOS/VS and how to ready DOS/VS for input jobs. Following the description of the method is an example of how to IPL DOS/VS from the virtual card reader.

IPL FROM THE CONSOLE

When a user is sure that he has all the virtual unit record devices he needs, that the console is properly defined, and that all required DASD devices are attached, he should enter this command to make extended control (EC) mode active for the virtual machine because DOS/VS needs EC mode to page:

```
set ecmode on
```

However, if this option is specified in the virtual machine's directory entry, the user does not have to specify it.

To load DOS/VS into the virtual machine, enter the IPL command:

```
ipl 250
```

After a few seconds, the system enters a wait state. On a real system console, the wait light goes on. On the terminal, a user may want to let a few seconds pass to be sure that the wait state has been entered. To verify that the system is in a wait state, enter CP mode and use the DISPLAY command to display the PSW:

```
display psw
```

If bit 14 is a 1, the system is in a wait state. If not, use the BEGIN command to resume program execution.

After determining that the system is in a wait state, cause an attention interruption by pressing the attention key (or equivalent). The following message asks the user to enter the name of the DOS/VS supervisor:

```
0I03A  SPECIFY SUPERVISOR NAME
```

Entering a null line causes DOS/VS to use the default supervisor, $$A$SUP1.

Shortly after entering the supervisor name, the system enters the wait state again. Allow a few seconds to pass to be sure that the wait state has been reached. Then, cause another attention interruption with the attention key.

Next, DOS/VS displays a series of messages that display the status of the IPL procedure, followed by a prompting message:

```
0I10A  GIVE IPL CONTROL COMMANDS
```

In response to this message, enter these commands in this order:

1. The ADD or DEL commands to optionally alter the default DOS/VS configuration, which is established at system generation.
2. The SET command (required) to initialize the date and time clock.
3. The CAT command to optionally define the VSAM master catalog.
4. The DPD command (required) to define the page data set.

After entering the DPD command, this message appears:

```
0I20I DOS/VS IPL COMPLETE
```

It signifies that DOS/VS is loaded into the virtual machine.

If a warm start copy of the SVA (shared virtual area) is available, this message also appears:

```
1T00A WARM START COPY OF SVA FOUND
```

In response, enter KEEP (or a null line) or REJ, depending upon whether this copy of the SVA is to be used.

If no warm start copy of the SVA is available and the SVA must be used, create one by using a standard procedure, depending upon what is available in DOS/VS.

When the IPL procedure is complete, this message appears:

```
BG 1I00A READY FOR COMMUNICATIONS
```

It indicates that the background partition is running and is ready to accept control commands or job control statements.

The complete VM/370 logon and DOS/VS IPL procedure as it would appear on a 3270 terminal is shown in Figure 16. The exclamation marks (!) indicate pressing the attention key (or its equivalent).

```
logon tester
ENTER PASSWORD:

FILES:  001 RDR,  NO PRT,  NO PUN        (see Note 1)
LOGON AT 08:19:52 EST MONDAY 01/12/76
set ecmode on
link dosys 250 250 w        (see Note 2)
DASD 250 LINKED R/W
ipl 250        (see Note 3)
!
0I03A SPECIFY SUPERVISOR NAME
$$a$sup2
!
0I04I IPLDEV=X'250',VOLSER=DOSRE3,CPUID=FF0101530155
0I30I DATE=01/12/76,CLOCK=16/35/09,ZONE=EAST/04/00
0I10A GIVE IPL CONTROL COMMANDS
set        (see Note 4)
dpd
0I52I PAGE DATA SET EXTENT       LOW    HIGH
                              327   0 250  11
0I20I DOS/VS IPL COMPLETE
BG
1I00A  READY FOR COMMUNICATIONS.
BG        (see Note 5)
log
BG
assgn sysrec,x'250'
BG
set rf=yes
BG
       (see Note 6)
BG
// JOB TEST1

DATE 10/30/75,CLOCK 16/35/47
BG
1I89A  IPL REASON CODE =        (see Note 7)

BG
1I91A  SUB-SYSTEM ID =

BG
1I93I  RECORDER FILE IS   2% FULL
BG
// OPTION NODECK        (see Note 8)
BG
// EXEC ASSEMBLY
BG
EOJ TEST1

DATE 10/30/75,CLOCK 16/37/49,DURATION 00/02/01
BG
1C00A  ATTN. 00C        (see Note 9)
BG
       (see Note 10)
BG
0P08A    INTERV REQ SYSRDR=00C
```

Figure 16. IPL DOS/VS and Execute a Job in the Card Reader (Part 1 of 2)

Notes

1. The reader file contains a job stream for the DOS/VS virtual machine.

2. The DOS/VS system residence is assumed to be defined at virtual address 250 in userid DOSYS's directory entry and have a write password of ALL.

3. After the IPL command, the attention interruption causes message 0I03A to be issued. After entering the supervisor name, a later interruption continues the IPL procedure.

4. The SET and DPD commands are required to IPL DOS/VS.

5. The background partition is active and waiting for commands. The LOG command is optional; the ASSGN and SET commands shown here may be required for system recording.

6. A null line signals an interruption to the card reader, so that DOS/VS begins reading the job stream.

7. These are RDE (reliability data extractor) messages; a null line entered in response indicates that the user is taking the default values.

8. DOS/VS continues reading the job.

9. The card reader is empty; the spool file has been read.

10. A null line causes another interrupt to the card reader; if another file is in the card reader, it is read. Otherwise, message 0P08A is issued.

Figure 16. IPL DOS/VS and Execute a Job in the Card Reader (Part 2 of 2)

IPL FROM THE CARD READER

Place the control commands for performing the IPL procedure in the card reader of the DOS/VS virtual machine before issuing the IPL command to load the system. Then, signal DOS/VS to read the control commands from the card reader. This method can be more efficient than entering all of the control commands manually, especially if there are many ADD and DEL commands that must be issued when initializing DOS/VS.

The cards required to perform the IPL procedure must be in two separate card files: (1) a single card specifying the supervisor name, and (2) a card deck containing the IPL commands. A user may follow these card files with additional files that contain jobs for execution in the DOS/VS virtual machine.

To load DOS/VS into the virtual machine, enter the IPL command:

```
ipl 250
```

When the system enters a wait state, IPL DOS/VS from the card reader by causing a reader interruption. This interruption allows the system to read the name of the supervisor from the card reader. To cause a reader interruption, enter the CP environment by pressing the attention key twice (or the 3270's PA1 key once) to cause a CP read, and enter these commands:

```
#cp ready 00c
#cp begin
```

The READY command causes a reader interruption; the BEGIN command returns control to DOS/VS which reads the first spool file from the card reader.

Shortly after this card file is read, the system enters the wait state a second time. The user must again enter the CP environment and enter these commands:

```
ready 00c
begin
```

In response to these commands, DOS/VS begins reading the IPL commands.

Note: When initializing DOS/VS through the card reader, a user cannot supply the responses necessary to save the warm start copy of the SVA from card input. These responses must be supplied from the console. However, to create the SVA and SDL during IPL, place the cards to perform these procedures in the card reader in a separate spool file following the IPL commands. Again, the user must enter the READY 00C command to cause the reader interruption to force the system to begin reading from the card reader.

DOS/VS Operation

Depending upon how DOS/VS was generated, there may be additional operator commands and control statements that must be entered at the console running jobs on the DOS/VS virtual machine.

If there is an active system recorder file, it is opened when the first // JOB card is encountered in the input stream. Before this JOB card is read, enter the ASSGN and SET commands that define the SYSREC device and the status of the system recorder file. Otherwise, an error is encountered opening the SYSREC file. For example: If the system recorder file is already active on the system residence volume, enter:

```
assgn sysrec,X'250' (for DOS/VS Release 34 or earlier only)
set rf=yes
```

When starting a DOS/VS virtual machine to run in batch mode to process jobs from other users, a user may also want to enter the operator commands necessary to:

- Allocate storage among different partitions
- Start foreground partitions in operation
- Initialize POWER/VS

These considerations are discussed later in this section under the topic "Running Batch DOS/VS under VM/370." When alternating between CMS and DOS/VS, a user may want to keep the IPL procedure as simple as possible.

STARTING A JOB STREAM

After preparing job streams and placing them in the DOS/VS card reader, the message READY FOR COMMUNICATIONS appears. Enter a null line (with the return or enter key) to cause an interruption. This interruption causes DOS/VS to begin reading from the card reader.

If the LOG command was entered before beginning the job stream, DOS/VS displays on the user's terminal all the job control statements that are executed.

As the DOS/VS operator, the virtual machine user can enter control statements directly from the terminal. For example: To execute cataloged programs or procedures, enter the ASSGN, DLBL, and EXEC statements necessary to execute the program directly from the console.

WHEN A JOB IS FINISHED

When the DOS/VS virtual machine running a single partition finishes reading a spool file (which may contain one or more jobs), it posts this attention message to indicate that the reader is empty:

```
1C00A  ATTN. 00C
```

If additional jcbs are in the card reader and were spooled as separate CP spool files, enter a null line to cause DOS/VS to begin reading from the card reader. If no more files are in the reader and the user enters a null line, this message appears to indicate that operator intervention is required:

```
0P08A    INTERV REQ SYSRDR=00C
```

If desired, users can put cards into the real system card reader to direct another job stream to the DOS/VS virtual machine. When the DOS/VS virtual machine receives cards in its reader, it begins reading them automatically.

If the card reader of the DOS/VS virtual machine is spooled with the CONT operand, then any jobs received in the card reader while a job is executing are read upon completion of the current job stream. If a job stream completes and if the end of the spool file is reached before another job is received, an interruption must be issued to cause the next job to be read.

To terminate the DOS/VS terminal session, use the attention key (or equivalent) to enter the CP command environment. Under CP, either enter the LOGOFF command to log off the VM/370 system or use the IPL command to load another operating system into the virtual machine.

COMMUNICATING WITH CP

While operating the DOS/VS virtual machine, use CP commands to:

- Communicate with the system operator or other virtual machine users
- Query the status of virtual machine devices or spool files
- Attach or detach devices from the virtual machine configuation

To enter a CP command while the DOS/VS virtual machine is in operation, press the attention key (or its equivalent) twice, quickly, to force a CP read. After entering the necessary CP commands, use the CP BEGIN command to resume DOS/VS virtual machine execution. For example: If a DOS/VS PAUSE control statement requests the VM/370 operator to perform some action, the user must enter the CP environment to send a message to the VM/370 system operator. The following lines represent a typical sequence on a typewriter terminal:

```
// PAUSE ASK OPERATOR TO ATTACH TAPE AS 284
!!
CP
msg op please attach scratch tape as 284
sleep
TAPE 284 ATTACHED
!
CP
begin
```

The SLEEP command locks the keyboard and places the virtual machine in a dormant status to wait for any messages. When the message appears indicating the tape is attached, press the attention key once to return to CP, and then issue the BEGIN command to resume virtual machine execution. Because the // PAUSE message is still outstanding, press the RETURN key to continue DOS/VS execution.

Using the #CP Function

In most cases during virtual machine operation, use the #CP function to enter CP commands directly from the virtual machine environment. Users do not always have to press the attention key (or its equivalent) to enter the CP environment. For example: If the virtual machine is waiting for a read, a user can enter a CP command with the #CP function:

```
#cp msg op please mount vol240
```

The command line is processed by VM/370, and the virtual machine is still waiting for a read. This method may be convenient for entering CP commands.

Note: At times CP commands cannot be entered with the #CP function. For example: During the IPL procedure when DOS/VS is processing IPL commands, the CCWs used for these reads expect only three bytes of data. Any additional information on CP command lines is truncated.

Interrupting the Virtual Machine

While DOS/VS is running in the virtual machine, a user can interrupt its execution by using the attention key (or its equivalent) on the terminal. When this key is pressed, the DOS/VS attention handler responds with these messages:

```
AR
1I60A  READY FOR COMMUNICATIONS.
AR
```

When these messages appear, a user can enter attention commands. To resume program execution, enter a null line. Normally, wait until the attention has been processed before signaling another one. An exception would be when canceling a dump.

When using a 2741 terminal and its attention key mainly to signal CP interruptions, enter the command:

```
#cp terminal mode cp
```

The first time the attention key is pressed, VM/370 posts a CP interruption. The next pressing of the attention key signals an interruption to DOS/VS. When a user is in the CP environment and wants to signal an interruption to DOS/VS, enter either the ATTN or REQUEST commands.

Running Batch DOS/VS Under VM/370

When using DOS/VS in a virtual machine as a production tool, it is likely that the virtual machine running DOS/VS is going to be logged on continuously. This machine may be available for many users to submit jobs, or it may be used only by installation personnel responsible for running the production jobs.

In either event, it is likely that DOS/VS has been generated specifically for use under VM/370. In this case, a user should know whether:

- It is necessary to start more than one partition. If it is, determine how much virtual storage to allocate to each partition. These considerations are much the same as they would be for a native DOS/VS user, who must decide how much work is going to be done and what is the most efficient way to do it.

- To generate the POWER program (POWER/VS for DOS/VS or VSE/POWER for DOS/VSE). This program can provide many functions that are not available when relying solely on CP spooling, such as spooling jobs via class and purging selected jobs in a job stream.

  When the POWER program is active in the DOS/VS virtual machine, it controls which jobs are to be processed in the various partitions, and it reads jobs from the card reader. Because the program is constantly working, no need exists for an attention interruption when a new job is placed in a card reader.

  To start the POWER program in a virtual machine, use the AUTOSTART procedure. Enter the card deck for the automatic start either using cards in the reader or through the virtual card reader.

- Virtual devices are dedicated for use by the DOS/VS virtual machine or devices must be shared among other virtual machines.

  For example: If a card reader has been dedicated to a DOS/VS virtual machine, then users may submit jobs through that card reader. They do not have to place a CP ID card at the beginning of the deck to direct it to the appropriate virtual machine. If the DOS/VS virtual machine is sharing the system card reader, then any user submitting a card deck must place a CP ID card at the beginning of the deck, specifying the userid of the DOS/VS virtual machine.

Alternating Between CMS and DOS/VS Under VM/370

When working in a development and testing environment (rather than in a batch environment) and the work is not suitable for CMS/DOS, these are some advantages to alternating between CMS and DOS/VS:

- Reduced unit record output. Under CMS, users can examine program output and compiler listings online, check the results and resubmit the job without printing a single page on the system printer or punching card decks.
- Faster turnaround time compared with batch alone; under CMS, users can see the results of program compilation and execution immediately, rather than waiting for output from a batch system.

This topic outlines the technique for alternating between operating systems. Before using this technique, users should be familiar with CMS, the conversational component of VM/370, particularly with the CMS editor and some file system commands. CMS usage information is in VM/370 CMS User's Guide. For details on CMS commands and EDIT subcommands, refer to VM/370 CMS Command and Macro Reference.

LOADING CMS INTO A VIRTUAL MACHINE

To load CMS into a virtual machine, use the IPL command. Usually, IPL CMS by specifying the saved system name CMS:

```
ipl cms
```

Or, load CMS by specifying the virtual address of the CMS system, which is usually 190:

```
ipl 190
```

After receiving a message like this:

```
CMS VERSION 3.0
```

A user can use the interactive facilities of CMS to prepare jobs for execution in the DOS/VS virtual machine.

USING THE CMS EDITOR TO PREPARE JOBS

Use the EDIT command in CMS to pass control to the CMS editor for preparing disk files of 80-character card image records. The created files may contain DOS/VS job control statements, source files, or even IPL decks.

For example: To IPL DOS/VS using input statements from the card reader, prepare CMS files that contain:

- The DOS/VS supervisor name required for an IPL, such as the record:

```
$$A$SUP1
```

- The IPL control statements that a user wants to supply, such as:

```
set
dpd
assgn sysrec,x'250'
set rf=yes
log
```

Assume for the purposes of this example that: (1) these files have CMS file identifications of SUPER JCL and START JCL, and (2) in these files are all the statements needed to control DOS/VS IPL.

The CMS editor can also be used to prepare the job stream selected for execution. For example: To assemble an assembler language source program and make the source file available as a CMS disk file, edit the file and insert the DOS/VS job control statements into the CMS file. The file DOSTEST JCL might contain:

```
// JOB TEST1
// OPTION NODECK
// EXEC ASSEMBLY
   (assembler language source statements)
      .
      .
      .
/*
/&
```

Although this job stream contains only the job control statements necessary to assemble the job, it can also include the statements necessary to link-edit the output module, catalog the program, and so on.

ISSUING SPOOL COMMANDS TO CONTROL UNIT RECORD DEVICES

Before sending a job to the DOS/VS virtual machine, check the unit record devices:

- Close and purge the card reader, to make sure no files are left over from a previous job:

```
spool reader nocont
close reader
purge reader all
```

- Close and purge the card punch, and spool it to the card reader:

```
spool punch nocont
close punch purge
spool punch to *
```

When using the card reader to IPL DOS/VS, spool the punch NOCONT. At least the first two files must be separate spool files.

- Spool the virtual printer to the card reader:

```
spool printer to *
```

  For DOS/VS SYSLST output to print on the system printer, omit this SPOOL command. A user can also spool the printer file to a different class, such as L. This action ensures that the printer is closed before the user is ready to IPL CMS and that DOS/VS does not read the printer file from the reader:

```
spool printer to * class l
```

PUNCHING CMS FILES

Use the CMS PUNCH command to punch the card files. The files are spooled to the virtual card reader. For example, to punch the three files used above, enter:

```
punch super jcl (noheader
punch start jcl (noheader
punch dostest jcl (noheader
```

The NOHEADER option must be used to suppress punching a CMS READ control card, which is punched by default when using the PUNCH command.

INITIALIZING DOS/VS

When the DOS/VS system residence volume is attached to the virtual machine, use the IPL command to load DOS/VS:

```
ipl 250
```

After waiting a few moments, use the DISPLAY command to see if the system is in a wait state. After determining that the system is in a wait state, enter an attention interruption:

```
!!
CP
display psw
PSW = 030E000 00000000
ready 00c
begin
```

After this BEGIN command returns control to the virtual machine, the file SUPER JCL is read from the card reader, and the IPL procedure continues. Again, the user must wait for the system to enter a wait state and ready the reader:

```
!!
CP
display psw
PSW = 030E0000 00012800
ready 00c
begin
```

When the IPL procedure is complete, such messages as these appear:

```
0I52I PAGE DATA SET EXTENT      LOW       HIGH
                              327   0    250  11
0I20I IPL COMPLETE FOR DOS/VS REL xx.x ECLEVEL=nn
BG
1C00A  ATTN. 00C
BG
```

As a practical matter, an installation may want to create a DOS/VS saved system at this point so that the future loading of DOS/VS would avoid these preliminary steps. Refer to the VM/370 System Programmer's Guide for information on creating saved systems.

SIGNALING DOS/VS TO READ THE JOB STREAM

When DOS/VS has been loaded and the message BG indicates that it is waiting for communication, enter a null line. This action causes DOS/VS to begin reading the next spool reader file, which is the one that contains the job control statements, and in this example, the assembler language source program.

If the LOG command is issued during the IPL procedure, all of the job control statements that are read are displayed on the terminal as they are executed.

Note: If the RDE option is in effect for DOS/VS Release 34 (or earlier), respond to these messages before the job is executed:

```
1I89A  IPL REASON CODE =
1I91A  SUB-SYSTEM ID =
```

When the Card Reader Is Empty

When the job sent from the punch to the card reader has been read, this message appears, followed by a time stamp:

```
EOJ TEST1
```

The time stamp could look like this:

```
DATE 02/19/76,CLOCK 20/19/28 DURATION 00/07/48
```

Additional messages from the background partition can also appear, such as:

```
BG
1C00A ATTN. 00C
BG
```

When punching more than one job and the spool files for remaining jobs are still in the card reader, enter another null line to signal DOS/VS to read from the reader.

RELOADING CMS INTO A VIRTUAL MACHINE

When a job or jobs are finished in the DOS/VS virtual machine, a user may return to the CMS environment by entering CP mode and issuing this command:

```
ipl cms
```

This IPL command closes the virtual printer. If the printer is spooled to the card reader or if the printer is in a hold status, a message from VM/370 appears, such as:

```
PRT FILE 4786 TO BILBO    COPY 01  NOHOLD

      --or--

PRT FILE 4786 FOR BILBO    COPY 01 HOLD
```

This printer file contains the SYSLST output from the job that executed in DOS/VS.

If the file is spooled to the printer, it is queued for printing on the system printer. If the printer is spooled to the card reader, it is a reader file that is available to the user in the card reader.

EXAMINING DOS/VS VIRTUAL MACHINE OUTPUT

To examine a job's output executed under the DOS/VS virtual machine, spool the printer to the card reader and read the reader file onto the CMS A-disk by using the READCARD command:

```
readcard dostest output
```

This command creates a file named DOSTEST OUTPUT, which contains the spooled printer output. Now, using the CMS editor, either examine the contents of the file or use the TYPE command to display the whole file at the terminal.

Use the EDIT command to pass control to the CMS editor:

```
edit dostest output
```

To examine assembly or compilation output, use a LOCATE subcommand to locate a keyword in the listing file. For example: To locate the beginning of the diagnostic messages produced by the assembler, enter the subcommand:

```
locate /diagnostics
```

If no errors are in the assembly, modify the job control statements in the file and resubmit the job. Otherwise, correct the source statements and then start over. Starting over means that a user must repeat the procedure for clearing files from the card punch and card reader, punching the IPL decks and the job stream, and reinitializing DOS/VS.

USING EXEC PROCEDURES

When alternating extensively between CMS and DOS/VS in a virtual machine, place in an EXEC procedure the commands necessary to spool unit record devices, punch the IPL deck, and punch a job stream. Then, when sending a jcb to the card reader and initializing DOS/VS, a user only has to enter the EXEC name and, in some cases, a few additional control commands.

For example: The command sequence (previously mentioned) could be ccntained in an EXEC procedure, such as:

```
CP SPOOL PUNCH NOCONT
CP CLOSE PUNCH PURGE
CP CLOSE C
CP PURGE READER ALL
PUNCH SUPER JCL (NOH
PUNCH START JCL (NOH
PUNCH DOSTEST JCL (NOH
CP IPL 250
```

If this EXEC procedure is named DOSJOB, then to execute this procedure, all a user has to enter is:

```
dosjob
```

Once the IPL command in the EXEC is performed, the virtual machine is no lcnger under the control of CMS. To begin DOS/VS operation, enter attention interruptions and CP commands, as necessary.

A user can make an EXEC procedure more generalized. For example: To make this EXEC capable of sending any job to the card reader, use the EXEC symbol &1 in place of the DOSTEST filename, such as:

```
CP SPOOL PUNCH NOCONT
CP CLOSE PUNCH PURGE
CP CLOSE C
CP PURGE READER ALL
PUNCH SUPER JCL (NOH
PUNCH START JCL (NOH
PUNCH &1 JCL (NOH
CP IPL 250
```

With this EXEC, a user can send any job to the card reader that has a CMS filetype of JCL. For example: If a user enters:

```
dosjob prog3
```

The EXEC variable symbol &1 is replaced with the argument PROG3 and the file PROG3 JCL is punched to the card reader for execution under DOS/VS.

As an additional aid when entering the commands and responses necessary to IPL DOS/VS from the card reader, use the CONT option of the SPOOL command. This option allows a user to spool the IPL commands and job stream as a single spool file. For example:

```
CP SPOOL PUNCH NOCONT
CP CLOSE PUNCH PURGE
CP CLOSE C
CP PURGE READER ALL
PUNCH SUPER JCL (NOH
CP SPOOL D CONT
PUNCH START JCL (NOH
PUNCH DOSTEST JCL (NOH
CP SPOOL D NOCONT
CP IPL 250
```

When spooling the punch with the CONT operand, VM/370 spools the START JCL and DOSTEST JCL files as a single spool file. When the IPL commands are read, DOS/VS continues reading from the card reader. A user does not have to signal (with a null line) when DOS/VS is to begin reading the job stream.

Continuous spooling has an additional advantage in the IPL procedure. When issuing the IPL command, the virtual punch is closed. However, in the previous example where the punch was spooled NOCONT, but not closed, the IPL closes the punch. As the file is spooled to the reader, this action causes a reader interruption, which is the first interruption that a user has to enter (the one that causes DOS/VS to read the supervisor name).

Thus, when executing this EXEC format, a user is required (after the IPL command is executed) to enter only one interruption and one READY command to execute the entire job. The console sheet might look like this:

```
dosjob
!!
display psw
PSW = 030E0000 000128000
ready 00c
begin
```

After issuing this BEGIN command, the remainder of the job is executed without user intervention until the card reader is empty.

The CMS EXEC facility is described in detail in the VM/370 CMS User's Guide.

Using More Than One Virtual Machine

In a DOS/VS virtual machine, if a user is running a job that may take a long time to execute, he may want to free his terminal for other work. In these situations, use the DISCONN command to disconnect the DOS/VS virtual machine and log onto some other userid.

This topic shows a sample procedure (using the userids CMSPREP1 and DOSTEST1), followed by a list of some additional things that must be considered when disconnecting a terminal.

Note: While it is not necessary to use CMS to prepare or transmit the jobs to the DOS/VS virtual machine, users may find it convenient.

ACCESSING CMS

To access CMS, a user must first have a userid. A user can log onto that userid and load CMS as follows:

```
logon cmsprep1
ENTER PASSWORD:

LOGON AT 10:30:41 EST TUESDAY 02/28/76
ipl cms
CMS VERSION 3.0
```

Assuming that the user has a read/write CMS A-disk, a user can create CMS files that contain the IPL control commands and responses, as well as the job streams to execute in DOS/VS. Then, by using the SPOOL and PUNCH commands, place copies of these files in the card reader of the machine that is going to run DOS/VS.

For example: A user has two files named SUPER JCL and START JCL, which contain the supervisor name and IPL commands for the IPL procedure. In addition, the file DOSTEST JCL contains the job stream that a user wants to execute. To spool these files to the userid DOSTEST1, enter:

```
cp spool punch to dostest1
punch super jcl (noheader
punch start jcl (noheader
punch dostest jcl (noheader
```

DISCONNECTING CMS

When a user is ready to log onto the userid that is going to run DOS/VS, disconnect the CMS virtual machine as follows:

```
disconn hold
```

A user should use the HOLD operand of the DISCONN command when he uses a dial-up terminal and does not want to lose the connection.

Since the CMS machine is not currently active, there is no need to disconnect it. While a user could just as easily log off, disconnecting and logging on again saves reloading CMS or respooling the punch, printer, and so on.

LOGGING ONTO DOS/VS

When logging onto the virtual machine that is going to run DOS/VS, a user sees, in addition to the normal log messages, a message indicating that there are files in the card reader:

```
logon dostest1
.
FILES:  003 RDR,  NO PRT,  NO PUN
LOGON AT 10:50:34 EST TUESDAY 02/28/76
```

If this virtual machine does not have the ECMODE option set on (determined by issuing the QUERY SET command), issue the command SET ECMODE ON. Then, begin the IPL procedure as outlined under the topic "IPL from the Card Reader" (described previously in this section).

Note: If the RDE option is in effect for DOS/VS Release 34 (or earlier), wait until after responding to the RDE messages before disconnecting the DOS/VS virtual machine. Then, enter CP mode, using the attention key, and enter the SET RUN ON and DISCONN commands:

```
!!
CP
set run on
disconn
```

The DOS/VS virtual machine continues to run.

RETURNING TO CMS

A user can now use the VM/370 logon procedures to reconnect to the CMS virtual machine. During logon, this message appears instead of the normal LOGON message:

```
RECONNECT AT 11:05:02 EST TUESDAY 02/28/76
```

To return to the CMS environment and continue working, enter the BEGIN command.

To see if the virtual machine that is set up to run DOS/VS is running, issue this command:

```
query dostest1
```

After issuing this command, a user can continue to use CMS (or some other operating system) in this virtual machine.

If desired, users can again disconnect the CMS virtual machine and reconnect onto the DOS/VS virtual machine. For example: A user knows that the job stream being executed may pause to require an operator response. Or, a user may use CMS to spool another job to DOS/VS. Then, a user may need to reconnect to the DOS/VS virtual machine to alert DOS/VS to begin reading from the card reader.

After reconnecting, issue the BEGIN command for the DOS/VS virtual machine to resume execution.

DISCONNECTION CONSIDERATIONS

When using more than one userid to alternate between two operating systems, consider:

- How DOS/VS may read additional jobs from the card reader?
- What happens when there is a read from the console of the DOS/VS virtual machine?
- What happens to the console log of a disconnected virtual machine?

Sending Jobs to a Disconnected DOS/VS Machine

When running DOS/VS disconnected, a user must reconnect to the DOS/VS virtual machine to enter the interruption that causes DOS/VS to continue reading jobs.

To use CMS to spool jobs to a disconnected DOS/VS virtual machine, spool the reader of the DOS/VS machine with the CONT operand:

```
spool reader cont
```

Then, if another job is received in the card reader of the DOS/VS machine before the currently executing job stream has completed, the job just received is also read and executed. Thus, when running a series of jobs in a single job stream and the reader is spooled with the CONT operand, a user can continue to send (from the CMS virtual machine) additional jobs to the DOS/VS virtual machine for execution.

Note: Under these circumstances, a user does not have to reconnect to the DOS/VS virtual machine to signal an interruption, unless the currently executing job stream finishes before the next job is received in the card reader.

If DOS/VS is running disconnected and is processing many jobs, a user may want to obtain printed output for completed jobs without waiting for all the jobs to finish.

When running DOS/VSE with the VSE/Advanced Functions Program Product (5746-XE8), VM/370 automatically releases spooled printer output to VSE/POWER. However, for DOS/VS Release 34 (or earlier), release spooled printer output (either accumulated directly or through the POWER/VS program) by reconnecting to DOS/VS and issuing the command:

```
close printer
```

This command releases the SYSLST output accumulated thus far. However, when using the POWER/VS program and a dedicated printer, all spooled output files are under the control of POWER/VS spooling, and not VM/370 spooling.

When Console Read Occurs in a Disconnected DOS/VS Machine

When running DOS/VS disconnected, a 15-minute time-out begins when a console read occurs. If the virtual machine does not respond to the read before the 15 minutes elapse, VM/370 automatically logs off the virtual machine.

For example: DOS/VS is running disconnected, and a program running in the machine completes execution or issues a PAUSE request. The virtual machine is logged off after 15 minutes unless the user reconnects the virtual machine and issues the BEGIN command.

The Console Log of a Disconnected DOS/VS Machine

When running DOS/VS disconnected, VM/370 ignores all output or "writes" to the virtual console unless the console is spooled. To spool virtual console output, a virtual machine user can issue the following CP command before disconnecting the virtual machine:

```
#cp spool console start
```

This command starts recording all console output on a spool file. When the user logs on again, he can issue:

```
spool console stop close
```

This command stops console spooling and releases the spool file to the real printer. If this command is not entered, VM/370 saves all spooled console output except the last 4K page of output.

Developing and Testing Programs to Run in a DOS/VS Virtual Machine

The foregoing discussions noted how to use the CMS editor and the EXEC facility to help prepare jobs for execution in a DOS/VS virtual machine. In addition to these CMS features, there are a number of other CMS commands for developing and testing programs on CMS disks. One advantage of storing source programs on CMS disks is that they can be maintained as backup copies of a program while a second version is being tested and debugged.

CMS has a special environment, called CMS/DOS, which provides many commands that simulate the functions of DOS/VS or DOS/VSE if VM/370 Basic System Extensions Program Product (5748-XX8) is installed. An installation needs this program product for VM/370 to support FB-512 devices in its configuration. (For DOS/VSE to access FB-512 devices, an installation also needs to install the VSE/VSAM Program Product, Program No. 5746-AM2.)

Some of the things that can be done in CMS/DOS are:

- Creating CMS macro libraries from DOS/VS macro libraries and assembling programs directly in CMS. (Assembler diagnostic messages are displayed on the terminal.)
- Compiling programs written in DOS/VS COBOL or DOS/VS PL/I programming languages, using DOS/VS macro libraries.
- Displaying or printing the directories of DOS/VS private or system core image, relocatable, source statement, or procedure libraries.
- Displaying or printing the procedure library.
- Link-editing TEXT decks from CMS disks, or relocatable modules from DOS/VS or private relocatable libraries. These simulated core image libraries called DOSLIBs are on a CMS disk. Users can also copy relocatable modules from DOS/VS libraries.
- Loading core image phases from CMS DOSLIBs or from DOS/VS core image libraries into virtual storage and executing them.
- Identifying system and programmer logical units for programs being used and listing current assignments.

- Identifying disk files. When executing programs in CMS/DOS, users can read sequential disk files directly from DOS disks, but cannot write on them. Instead, for testing purposes, write CMS disk files or output files to the virtual punch or printer, or to a tape. An exception to this rule is when executing COBOL and PL/I programs in CMS/DOS. CMS can be used to both read and write VSAM files located on DOS disks.

- Using the CMS and VM/370 debugging facilities to debug a program under CMS. Users can set address stops (called breakpoints in the CMS debug environment) and temporarily halt the execution of a program to examine or change the contents of registers or specific storage locations.

When a program is tested and debugged in CMS/DOS, users can also prepare a job stream to catalog and execute the program in a DOS/VS virtual machine.

For complete details about how to use CMS/DOS, refer to VM/370 CMS User's Guide. For details about how to specify CMS commands, refer to VM/370 CMS Command and Macro Reference.

Summary

When a virtual machine user loads DOS/VS into his virtual machine, the terminal becomes the DOS/VS operator console, and the virtual machine user becomes the operator responsible for entering all commands and responses. The three basic techniques for using DOS/VS in a virtual machine are: running DOS/VS in batch mode, using the IPL command to alternate between DOS/VS and CMS in a single virtual machine, and running DOS/VS disconnected.

Before using one of these techniques, an installation must understand how to:

- Generate DOS/VS to run in a virtual machine
- Create VM/370 directory entries for DOS/VS virtual machines
- Access the DOS/VS system residence volume
- Ensure that the proper I/O devices are attached to the DOS/VS virtual machine
- IPL and operate DOS/VS under VM/370

The primary objectives when generating DOS/VS to run in a virtual machine should be to avoid double CCW translation and to reduce the number of SIO instructions issued by DOS/VS. To meet these objectives, an installation needs to consider how it generates both VM/370 and DOS/VS. (DOS/VS can be generated under VM/370.)

DOS/VS operation depends upon how DOS/VS was generated. There may be additional operator commands and control statements that must be entered at the console before running jobs on the DOS/VS virtual machine.

There are many ways that DOS/VS virtual machine users can be helped by using the CMS component of VM/370. The CMS editor and EXEC facility can be used to help prepare jobs for execution in a DOS/VS virtual machine. CMS commands can be used to develop and test programs on CMS disks. The CMS/DOS environment provides many commands that simulate DOS/VS functions.

Section 4. OS/VS in a Virtual Machine

This section uses the term "OS/VS" as a generic expression. It represents any or all of the OS, OS/VS1, OS/VS2 SVS, and OS/VS2 MVS system control programs unless specified otherwise.

When loading OS/VS into a virtual machine running under VM/370, the terminal becomes the OS/VS operator console, and the user is responsible for entering all the commands and responses normally required of the operator.

The three basic techniques to use when running OS/VS in a virtual machine are:

- Batch mode. One user runs as the OS/VS machine (userid OSVS) and other users (like CMSID1) may submit jobs either through the virtual card reader, through the system card reader, or via JES remote stations.
- Alternating technique. The IPL command is used to alternate between OS/VS and CMS in a single virtual machine. This method requires only one directory entry, the one for the OS/VS user. Because of the lengthy IPL process, it is practical only if an installation has created an OS/VS saved system.
- Disconnected user (OS/VS2 only). Because OS/VS2 allows a user to recall a prior system message, he can log on as an OS/VS2 operator under the OSVS userid, start up his system, and then disconnect. While the OS/VS2 machine continues to run, the user can log on as a CMS user (CMSID1) and create and submit job streams and check the resulting output. To check the progress of the operating system, disconnect from the CMS machine and reconnect to the OSVS virtual machine via the LOGON command.

Before discussing these three techniques in greater detail, the user must understand how to:

- Generate OS/VS to run in a virtual machine
- Create VM/370 directory entries for OS/VS virtual machines
- Access the OS/VS system residence volume
- Ensure that the proper I/O devices are attached to the OS/VS virtual machine
- IPL and operate OS/VS under VM/370

System Generation Recommendations

When generating OS/VS to run in a virtual machine, an installation should have these primary objectives:

- To have all commonly used transient routines made residence in storage
- To run all jobs (if possible) as V=R jobs

To meet these objectives, an installation needs to consider how it generates both VM/370 and OS/VS.

For example: OS/VS2 Release 1 (referred to as Single Virtual Storage or SVS) can use two address spaces:

- One address space for V=V jobs (that is, jobs executing even though some of their pages are not in real storage)
- Another address space for SVS and any V=R jobs

By defining the SVS virtual machine large enough for all jobs to run V=R, SVS does not have to alternate between address spaces. It should perform better under VM/370 than if it had to alternate between address spaces.

VM/370 RECOMMENDATIONS

When generating VM/370 for an OS/VS virtual machine, note the following recommendations:

VM/370 Saved Systems

IPL time can be reduced by saving any operating system after the generated operating system has been load on VM/370. For more information about generating saved systems, refer to the VM/370 System Programmer's Guide.

Handshaking for VS1

VS1 Release 4 and subsequent releases use VM/VS handshaking. VM/VS handshaking permits instructions issued by VS1 in a virtual machine to be processed directly by the processor. It also permits VM/370 to simulate privileged instructions. For further details, refer to the topic "VM/VS Handshaking for VS1" in this section.

OS/VS RECOMMENDATIONS

When generating OS/VS to run in a virtual machine, note the following recommendations:

Specifying Options

Very often, options that improve performance on a real machine have no effect (or possibly an adverse effect) in a virtual machine. For example: SEEK separation, which improves performance on the real machine, is redundant in a virtual machine. VM/370 itself issues a stand-alone SEEK for all disk I/O.

When VM/370 is the primary operating system and another operating system, such as VS1, is running one or two partitions in a virtual machine under it, generate the other operating system with as few options as possible, particularly when several virtual machines share the same system residence volume.

When VM/370 is not the primary operating system and the other operating system is usually run without VM/370, generate the other operating system to:

- Be transparent to the users of the other system
- Have the required number of partitions or regions

Sharing the System Residence Volume

Sharing the system residence volume avoids the need to keep multiple copies of the operating system online. The shared system residence volume should be read-only. To share OS/VS among users, remove all data sets with write access from the system residence volume.

OS/VS1 RECOMMENDATIONS

When generating VS1 to run in a virtual machine, note the following recommendations:

VS1 Storage Limits

The hardware storage size used by VM/370 may be larger or smaller than the hardware storage sizes supported by VS1. In the VM/370 directory for the VS1 user, use the USER statement to define the minimum and maximum virtual storage sizes for the VS1 virtual machine. For the VS1 system, generate it to support the hardware storage size of the real machine on which the VS1 system is to run.

For example: In the USER directory statement, specify the minimum and maximum storage sizes supported for the VS1 virtual machine. Define the minimum storage size as 1 megabyte -- the minimum storage size supported by VS1. Define the maximum storage size according to the VS1 release level (such as VS1 Release 6, which has a 16 megabyte storage limit in nonpaging mode and an 8 megabyte storage limit in paging mode). For the VS1 system to run more efficiently in the VS1 virtual machine, generate its real storage size for 2 megabytes -- the storage size of the real processor. Thus, this system generation specification establishes an initial VM/370 virtual storage size of 2 megabytes even though the minimum VM/370 storage definition was 1 megabyte.

By using VS1 in nonpaging mode, VM/370 handles the paging and CCW translation for VS1, thereby eliminating the VS1 overhead associated with these functions. For a description of VM/VS handshaking between VS1 and VM/370, refer to the topic "VM/VS Handshaking for VS1" later in this section.

VS1 in a V=R Virtual Machine

When running VS1 in a V=R machine, a user can avoid data transfer operations into real page zero by doing one of the following:

- If the VS1 nucleus already exists, replace the existing ORDER statement with the following linkage editor control statement in the VS1 linkage editor deck:

  ```
  ORDER IEAAIH00,IEAIOS00(P)
  ```

  Use all INSERT control statements that were produced during the original VS1 system generation process.

- Generate a new VS1 nucleus prior to stage II execution and perform IOS alignment by modifying the ORDER control statement in the VS1 stage II job stream.

VM/VS HANDSHAKING FOR VS1

VM/VS handshaking is a communication path between the control program (CP) component of VM/370 and VS1 Release 4 (and subsequent releases) running as a virtual machine under VM/370.

To improve their operation with VM/370, systems generated to use VM/VS handshaking can run both in a real machine and in a virtual machine. In a virtual machine, systems that have VM/VS handshaking can more realistically simulate the operation of their real machine.

VM/VS handshaking consists of:

- Closing CP spool files when job output is complete. This function allows VM/370 to immediately process these output files without operator intervention.

- Processing pseudo page faults. When the pseudo page fault handling portion of handshaking is active, one task can be dispatched while another is waiting for a page to be brought into real storage.

- Providing a nonpaging mode to eliminate duplicate paging.

- Providing a way to avoid a PCI (programmed-controlled interruption) in a BTAM autopoll CCW loop.

- Providing miscellaneous enhancements when running under VM/370.

Activating VM/VS Handshaking for VS1

Although handshaking is a system generation feature for VS1, it is active only when VS1 is run under the control of VM/370; it is disabled when that same VS1 operating system is run on a real machine. The VM/VS handshaking feature is active when:

- VS1 is generated with the VM/370 option.

- The virtual machine storage space is at least 1 megabyte.

Note: If nonpaging mode is used, refer to the subtopic "VS1 Nonpaging Mode" described later in this discussion.

When loading a VS1 virtual machine that has the handshaking feature, the VS1 initialization routines determine whether the handshaking feature is available. VS1 checks for VM/370 by issuing an STIDP (store processor ID) instruction. When STIDP returns the version code X'FF', VS1 is running under VM/370.

On receiving version code X'FF', VS1 issues a DIAGNOSE code X'00' instruction tc store the VM/370 extended-identification code. If VM/370 returns a code to VS1, VM/370 supports handshaking; otherwise, VM/370 does not support handshaking.

The psuedo page fault portion of handshaking may be turned on and off with the CP SET PAGEX command. When using the CP IPL command again, PAGEX is turned off.

Pseudo Page Faults

A page fault is a program interruption that occurs when a page marked "not in storage" is referred to by an instruction within an active page. VM/370 places the virtual machine operating system referring to the page in a wait state while the page is brought into real storage. Without handshaking, VM/370 places the entire VS1 virtual machine in page wait until the needed page is available.

However, with handshaking, a multiprogramming (or multitasking) VS1 virtual machine can dispatch one task while waiting for a page request tc be answered for another task. VM/370 passes a pseudo page fault (program interruption X'14') to VS1. When VS1 recognizes the pseudo page fault, it places only the task waiting for the page-in page wait and can dispatch any other VS1 task. Thus, when VS1 uses pseudo page faults, its execution under the control of VM/370 more closely resembles its execution on a real machine.

When a page fault occurs for an VS1 virtual machine, VM/370 ensures (1) that the pseudo page fault portion of handshaking is active and (2) that the VS1 virtual machine is in EC mode and enabled for I/O interruptions. Then, VM/370 reflects the page faults to VS1 by:

- Storing the virtual machine address that caused the page fault at location X'90' (the translation exception address)
- Reflecting a program interruption (interruption code X'14') to VS1
- Removing the VS1 virtual machine from page and execution wait

When VS1 recognizes program interruption code X'14', it places the associated task in a wait state. VS1 can then dispatch other tasks.

When the requested page is available in real storage, VM/370 reflects the same program interruption to VS1, except that a bit in the translation exception address field is set to one to indicate completion. VS1 removes the task from page wait, and the task is then eligible to be dispatched.

Note: VS1 with handshaking is not designed to run in a VM/370 virtual machine that is itself running under VM/370. Otherwise, when a pseudo page fault occurs, the second-level VM/370 system (VM/370 under VM/370) does not recognize the page fault and terminates with a PRG020 abend code.

VS1 Nonpaging Mode

When both VM/370 and VS1 support handshaking, full handshaking results when VS1 runs in nonpaging mode. However, handshaking does not require nonpaging mode. When VS1 is run under the control of VM/370, it executes in nonpaging mode if:

- Its virtual storage space is equal to the storage space of the VM/370 virtual machine.
- Its virtual machine storage space is at least 1 megabyte.
- VM/VS handshaking is available.

The VS1 virtual machine operator initiates nonpaging mode by issuing the CP SET PAGEX ON command.

Provided that the above conditions are satisfied when VS1 is loaded under control of VM/370, VS1 issues a special message after the IEA760A SPECIFY VIRTUAL STORAGE SIZE message:

```
IEA788I NON-PAGING MODE OF OS/VS1 UNDER VM/370
```

When VS1 executes in nonpaging mode, it uses fewer privileged instructions and avoids duplicate paging. The VS1 nucleus initialization program (NIP) fixes all VS1 pages to avoid duplicate paging.

Note: The VM/370 working set size (the estimated number of real storage pages that a virtual machine needs to execute) may be larger for a VS1 virtual machine in nonpaging mode than for one not in nonpaging mode.

Considerations unique to nonpaging mode are:

- Responding to virtual storage size message

  An EOB or U response to the VS1 SPECIFY VIRTUAL STORAGE SIZE message automatically sets the VM/370 virtual storage space equal to the VS1 virtual machine storage space, provided the latter is 1 megabyte or larger.

- Nonpaging mode storage limits

  Storage limits for nonpaging mode are the same as for VS1 itself:

  - VS1 Release 6 has a 16 megabyte storage limit in nonpaging mode and an 8 megabyte limit in paging mode (the limit is equal to the real machine size or configuration as supported by VS1). During IPL, VS1 issues a message that specifies these limits.
  - VS1 Release 5 has a 4 megabyte storage limit and issues a message to that effect.
  - VS1 Release 4 has a 4 megabyte storage limit, but issues no message to that effect.

- Providing a minimum size VS1 nucleus

  A minimum size VS1 nucleus tends to be more suitable for the nonpaging mode. It provides more space for problem program partitions.

- VS1 storage mapping unaffected by nonpaging mode

  In nonpaging mode, VS1 maps virtual storage normally; that is, it puts these functions in the high addresses of virtual storage: the JES buffer pool, VTAM workspace, RTAM area, JES routines, resident modules, and the pageable supervisor. By minimizing the virtual storage requirements for these functions, VS1 can provide more problem program partition space.

- VS1 paging data set not used in nonpaging mode

  The VS1 paging data set is not used in nonpaging mode. The VS1 system does not require page parameters and page packs.

- Executing V=R jobs in nonpaging mode

  It is possible to execute V=R jobs in nonpaging mode. The V=R line is a valid IPL parameter and the V=R logic within VS1 is applicable. However, any benefits from such operation would appear to be questionable because the entire VS1 system functions V=R in nonpaging mode.

- FASTNIP forcing of nonpaging mode

  FASTNIP automatically forces nonpaging mode when the virtual machine storage space is 1 megabyte or larger.

Note: Although handshaking does not require nonpaging mode, there may be occasions to run a VS1 system in a virtual machine with a storage space of 1 megabyte or larger and not use nonpaging mode. To avoid initiating nonpaging mode, specify the virtual storage space explicitly to VS1 in response to message IEA760A; for example: R00, '6144'.

The following examples show whether nonpaging mode is initiated when initializing VS1 in a VM/370 environment with handshaking.

Example 1:

```
VM/370 Size = 768K
OS/VS1 Virtual Storage Size = 6M
IEA760A Response = 'EOB'
```

Nonpaging mode is not initiated, and the virtual machine storage space is less than 1M.

Example 2:

```
VM/370 Size = 1M
OS/VS1 Virtual Storage Size = 6M
IEA760A Response = 'U'
```

Nonpaging mode is initiated, and VS1 forces the virtual machine storage space to 1 megabyte. The VS1 system may not complete initialization because of insufficient virtual storage space.

Example 3:

```
VM/370 Size = 4M
OS/VS1 Virtual Storage Size = 4M
IEA760A Response = R00, '4096'
```

Nonpaging mode is initiated, and the explicit response happens to equal virtual machine storage space.

Example 4:

VM/370 Size = 3M
IEA760A Response = R00, '6144'

Nonpaging mode is not initiated. The explicit response sets virtual storage space to 6 megabytes which VS1 requires for paging space.

Closing CP Spool Files

When VM/VS handshaking is active, VS1 closes the CP spool files when the job output from the VS1 DSO, terminator, and output writer is complete. Once the spool files are closed, VM/370 processes them and sends them to the real printer or punch without operator intervention.

During its job output termination processing, VS1 issues DIAGNOSE code X'08' instructions to pass the CP CLOSE command to VM/370 for each CP spool file.

VS1 Without Handshaking

When a nonhandshaking copy of VS1 (prior to Release 4.0) is run under VM/370, the storage considerations are the same as if VS1 were running in native mode. The VS1 virtual storage space must be at least 512K larger than the virtual machine storage space.

The VS1 virtual storage space is specified at VS1 system generation time and can be altered in response to the IPL message IEA760A SPECIFY VIRTUAL STORAGE SIZE. The virtual machine storage space is specified initially in the VM/370 directory and can be altered by using the CP DEFINE STORAGE command.

BTAM Autopoll CCW Change Detection

When an operating system in a virtual machine has enabled the BTAM autopoll feature, it notifies VM/370 (via a DIAGNOSE instruction) whenever the autopoll CCWs are modified. VM/370 then modifies the real CCWs and does not check the autopoll CCWs for modifications each time the string is executed. This CCW change detection reduces VM/370 overhead and thereby improves the overall performance.

Note: If the autopoll feature is disabled for VM/370 (by the SET AUTOPOLL OFF command), a performance degradation occurs.

Miscellaneous Enhancements

When VS1 without handshaking is run in the VM/370 environment some duplication of function results. Because VS1 must perform certain functions when it is run on a real machine, it continues to perform all those functions in a VM/370 virtual machine, even though VM/370 also provides the services. However, with handshaking, VS1 avoids using many instructions and procedures that are redundant or less efficient in the VM/370 environment.

In either paging or nonpaging mode, VS1 avoids using:

- ISK (insert storage key) and SSK (set storage key) instructions; instead, VS1 uses a protection key table
- Seek separation for 2314 direct access devices
- The ENABLE/DISABLE sequence in the VS1 I/O supervisor (IOS)
- TCH (test channel) instructions preceding SIO instructions
- PCI (program-controlled interruptions) in the BTAM autopoll CCW sequence

In nonpaging mode, VS1 with handshaking avoids using:

- LRA (load real address) and RRB (reset reference bit) instructions (this is especially important when virtual machine assist is not enabled)
- The DIAGNOSE code X'10' instruction to release virtual pages or discontiguous storage
- VS1 paging and CCW translation

IBM 3850 MASS STORAGE SYSTEM CONSIDERATIONS

There are no special system generation requirements when generating OS/VS (OS/VS1 or OS/VS2 MVS) to use the MSS and operate in a virtual machine. Any VS1 or MVS system that supports the MSS can use VM/370 MSS support. VM/370 MSS support allows a VS1 or MVS virtual machine to:

- Use a dedicated mass storage control (MSC) port (or channel interface) and dedicated 3330V devices

--and--

- Act as the host for the VM/370 communicator program (which communicates 3330V mount and demount orders and responses between the MSC and VM/370)

However, this support requires each 3330V address defined in OS/VS to be identical to the 3330V address defined both to VM/370 and to the virtual machine using it.

For details about how to generate VM/370 to support the MSS and to install the VM/370 communicator program in either VS1 or MVS, refer to VM/370 Planning and System Generation Guide. For details about how VM/370 communicates with the MSS and uses it as well as how to provide backup and recovery for MSS volumes, refer to VM/370 System Programmer's Guide. For details about MSS initialization, refer to VM/370 Operator's Guide.

Generating OS/VS Under VM/370

This topic discusses the major steps for generating OS/VS in a virtual machine under VM/370. While the following procedures are for generating VS1, they are similar enough to SVS and MVS procedures to be used as examples. The primary difference between generating VS1 and SVS or MVS under VM/370 is VM/VS handshaking for VS1. Handshaking requires that a user specify the VM option in the VS1 SCHEDULR macro instruction.

In the DOS/VS in a virtual machine section, the alternating technique (using one virtual machine and multiple alternating systems) was used to generate DOS/VS. While convenient for DOS/VS where only one system could be executing at any one time, it is not a convenient technique for generating OS/VS. OS/VS system generation runs are much longer, and installations should use other methods that improve overall throughput.

In this topic, two virtual machines are used to generate OS/VS under VM/370. Figure 17 shows the directory entries for these two virtual machines: OSVSSYS and OSCMS.

The OSVSSYS virtual machine performs the majority of the system generation steps. In addition to the devices specified in the directory entry for user OSVSSYS, this user temporarily needs a dedicated tape drive at virtual address 181 on which to mount the starter system and distribution library tapes. Attaching this tape drive is explained later in this topic.

The OSCMS virtual machine is for preparing job streams for the OSVSSYS virtual machine, executing some steps in the system generation, and scanning output from OS/VS. By using the CMS editor, a user can create, store, and update the job streams used in the system generation runs. At the various stages of generation, the user can (by using the VM/370 spool system and CP spool file commands) load the appropriate job streams into the virtual card reader for OS/VS.

```
USER OSVSSYS PASSWORD 768K
  ACCOUNT ACCTNO BIN16
  OPTION ECMODE REALTIMER
    CONSOLE 01F 3210
    SPOOL 00C 2540 R
    SPOOL 00D 2540 P
    SPOOL 00E 1403
    MDISK 350 3330 0 404 DLIBA1 MR RPASS WPASS
    MDISK 351 3330 0 404 DLIBA2 MR RPASS WPASS
    MDISK 250 3330 0 404 OSVSYS MR RPASS WPASS

USER OSCMS PASSWORD 320K
  ACCOUNT ACCTNO BIN16
    CONSOLE 01F 3210
    SPOOL 00C 2540 P
    SPOOL 00D 2540 P
    SPOOL 00E 1403
    LINK CMSSYS 190 190 RR
    MDISK 191 3330 50 10 UDISK1 WR RPASS
```

Figure 17. Virtual Machines for OS/VS System Generation

PREPARING FOR OS/VS SYSTEM GENERATION

Before using the starter system and distribution system libraries for system generation, do the following:

- Initialize the volumes (DLIBA1 and DLIBA2) that are to contain the starter system and distribution libraries.
- Restore the starter system from tape to a DASD volume (DLIBA1).

- Use the starter system to copy the distribution libraries from the tape volumes (DLIBT1 and DLIBT2) to a DASD volume (DLIBA2).
- Create stand-alone card decks for independent utilities.
- List the VTOC of each current system volume (this listing can be used when reallocating data sets in the future).
- Initialize the volume that is to contain the new OS/VS.

One or Two Terminals?

The following examples in this topic assume that the two virtual machines (whose directory entries were shown in Figure 17) each have their own 3270 terminals. If two terminals are available, this is the most efficient method. Each system (CMS and OS/VS) runs independently with full terminal access.

However, a user can run the same procedures and use a single terminal. For example: To access the OSVSSYS virtual machine, place the OSCMS virtual machine in disconnect mode and log onto OSVSSYS. The disconnected virtual machine (OSCMS) continues to run. When ready to exchange virtual machines again, disconnect from the OSVSSYS machine and log back onto OSCMS. Logging back onto a disconnected virtual machine stops its execution. To resume operation, enter the CP BEGIN command.

Note: Before using the disconnect method of running two virtual machines from one terminal, note the disconnection considerations described later in this section.

INITIALIZING THE STARTER SYSTEM VOLUME

The utility control statements supplied as card input on a stand-alone system can be generated as CMS files in a VM/370 environment. The CMS editor and EXEC facilities, along with the VM/370 spool file system, allow a user to create, update, and store entire job streams or individual job steps. Data as well as job control language statements can be included in these CMS files.

For example: A user can use the OSCMS virtual machine to create the reader input required by the IBCDASDI utility program. To initialize the DASD volume to contain the starter system, log onto the OSCMS virtual machine, load CMS, and enter the following:

```
edit initstrt ojcl                    (open and identify new file)
input                                 (enter input mode)
initvol1 job
   msg todev=3210,toaddr=01f
   dadef todev=3330,toaddr=350,volid=scratch,passes=0
   vld newvolid=dliba1,ownerid=sysprogmr
   vtocd strtadr=14,extent=5
   end
(null line)                           (to return to edit mode)
file
```

The IBCDASDI control statements now reside in a CMS file. They are identified as INITSTRT OJCL and belong to the OSCMS virtual machine.

To transfer a copy of this file to the virtual reader of the OSVSSYS virtual machine, enter the following commands:

```
cp spccl punch to osvssys
punch initstrt ojcl (noheader)
```

These commands queue the punched file in the virtual reader of user OSVSSYS, whether OSVSSYS is logged on or not. If OSVSSYS is logged on and does not have its messages disabled (SET MSG OFF), a message at the terminal notifies him of the additional reader input. If OSVSSYS is not logged on, the notification message is displayed as part of the user's LOGON messages when he eventually logs on.

To perform the initialization, use a second terminal and log on to userid OSVSSYS. Send the following messages to the system operator:

```
msg op pls mount scratch 3330 pack as 350
msg op pls mount osvs1 starter tape as 181
```

In response to these messages, the system operator mounts a 3330 volume on some available disk drive, such as 150, and enters:

```
attach 150 to osvssys as 350
```

Similarly, after mounting the VS1 starter tape on an available tape drive, such as 471, he enters:

```
attach 471 to osvssys as 181
```

The user receives the following two messages to confirm the operator's action:

```
DASD 350 ATTACHED
TAPE 181 ATTACHED
```

From the OSVSSYS terminal the user can now enter these CP commands to load the IBCDASDI program:

```
ready 181
ipl 181
```

When loaded, IBCDASDI is the first file on the starter tape. After being loaded, the program goes into a wait state. To check for this wait state condition, display the PSW by issuing:

```
#cp display psw
```

To define the control statement input device (the virtual reader) to the IBCDASDI program, press the ENTER key (or its equivalent) to display this message:

```
IBC105A DEFINE INPUT DEVICE
```

Reply, in uppercase:

```
INPUT=2540,00C
```

When the volume initialization is complete, the user receives this message at his terminal:

```
IBC163A END OF JOB
```

After displaying this message, the system enters the wait state.

RESTORING THE STARTER SYSTEM TO DISK

As performed for the IBCDASDI program, a user at the OSCMS terminal can create a CMS file for the IBCDMPRS program and punch it to the virtual reader of the OSVSSYS virtual machine. The starter tape is now positioned at the end of the first file and ready to load the second file, the IBCDMPRS program. Use the OSVSSYS terminal to enter the command:

```
ipl 181
```

To define the control statement input device to the program, follow the same procedure as in the volume initialization step. When the user receives the END OF JOB message, the starter system has been restored to the DASD volume and can now be made operational.

LOADING THE STARTER SYSTEM

To start the interim starter system, enter the following command from the OSVSSYS terminal:

```
ipl 350 clear
```

When the user receives this message:

```
IEA760A SPECIFY VIRTUAL STORAGE SIZE
```

Enter a null line if the virtual machine size is less then 384K. For the 768K machine used in this discussion, enter:

```
R 00,'2048'
```

Continue replying to the prompting messages as directed in the appropriate system generation publication.

When the user receives this message:

```
IEE048I INITIALIZATION COMPLETED
```

Ready the starter system to process input, and enter the following commands to start normal system operation:

```
MN JOBNAMES,T
START RDR,00C
START WTR,00E
START INIT.P0,,,A
```

RESTORING DISTRIBUTION LIBRARIES TO DISK

Ask the system operator to mount a scratch pack as virtual address 351 to contain the distribution libraries:

```
#cp msg cp pls mount scratch 3330 pack as 351
```

At the OSCMS terminal, create the IEHDASDR control statement file for initializing the volume. Then, punch the file to the OSVSSYS machine for execution. Before executing the IEHDASDR utility program, vary the DASD volume offline.

After receiving the completion message:

```
IEH806I ANALYSIS OF DDNAME=SYSIN IS COMPLETE.
        VOLUME SERIAL NO.=DLIBA2
```

Vary the initialized volume back online.

The IEBCOPY utility program is used to unload the distribution libraries from tape to disk. The IEBCOPY control statements are in the form of load procedures and are contained in the first file of each distribution library tape.

Have the system operator mount the distribution library tapes and follow the procedures in the appropriate system generation publication to unload the distribution libraries to either one or two DASD volumes (depending upon their capacity).

CREATING CARD DECKS FOR UTILITY PROGRAMS

To punch out the independent utilities and IPL text, consider storing the card images in the OSCMS virtual machine.

Before running the IEBPTPCH program, issue the CP command:

```
#cp spool punch to oscms
```

This command sends the punched output to the OSCMS virtual reader. When the IEBPTPCH program has completed, enter the CP command:

```
#cp close punch
```

This command releases the file to the OSCMS virtual machine. At the OSCMS console, enter:

```
readcard utility output
```

This command creates a CMS file that contains all the card images punched. By using the CMS editor, create separate files for each utility, add appropriate control statements, and file them for future use.

INITIALIZING THE SYSTEM RESIDENCE VOLUME

Initialize the new system residence volume from the OSCMS machine while starting the stage I processing on the OSVSSYS machine. Use the CMS editor to create an IBCDASDI control statement file, and identify it as IBCDASDI CTLS. Use the EDIT subcommand GETFILE to insert the IPL TEXT file (previously punched from the distribution library volume). Then, perform the initialization by entering:

```
cp spool punch to * cont
punch ipl ibcdasdi (noheader)
punch ibcdasdi ctls (noheader)
cp spool punch nocont
cp close punch
cp ipl 00c
```

and replying to the prompting messages.

VM/370 UTILITY PROGRAMS

A user should also consider the VM/370 utility and service programs. Many of these programs perform functions that are practically identical to the OS/VS independent utilities:

- DDR: The VM/370 DASD dump restore (DDR) service program can be obtained by running it in stand-alone mode.
- IBCDASDI: The VM/370 IBCDASDI program is available on the system disk. It has a filename of IPL and a filetype of IBCDASDI. An added feature of the VM/370 version is its ability to initialize virtual disks (minidisks).
- ICAPRTBL: The VM/370 ICAPRTBL program is available by using the CP commands LOADBUF and LOADVFCB. Use the class D command LOADBUF to load the universal character set buffer (UCSB) or forms control buffer (FCB) for specific real printers. (For details about the LOADBUF command, refer to the VM/370 Operator's Guide.) Also, use the class G command LOADVFCB to load an FCB for specific virtual printers. (For details about the LOADVFCB command, refer to VM/370 CP Command Reference for General Users.)

For a description of the DDR and IBCDASDI programs and their operating procedures, refer to the VM/370 Operator's Guide.

STAGE I PROCESSING IN THE CMS VIRTUAL MACHINE

To process stage I, the CMS virtual machine can be used to:

1. Create the stage I input job stream (job control statements and system generation macro instructions).
2. Execute a single assembly.
3. Check the assembly listing for errors.

If any errors occur, repeat all three steps of the stage I procedure.

Note: The stage I assembly can actually be executed in either the OS/VS or CMS virtual machine, whichever is more convenient.

Preparing Stage I Input

Use the CMS editor to create and store the stage I input. The job stream can then be punched to the OSVSSYS machine's virtual reader for assembly under the OS/VS starter system. The CMS editor also allows the user to edit the job stream, make changes to it, and file the modified copy under a different name.

To perform the assembly in the CMS virtual machine, follow these steps:

1. The CMS virtual machine (OSCMS) must have access to the supervisor macro instructions in SYS1.AGENLIB. These macro instructions reside on volume DLIBA2, owned by the OSVSSYS virtual machine. To have access to these macro instructions, enter the following commands from the OSCMS terminal:

```
cp link osvssys 351 351 rr
acc 351 b
filedef cmslib disk osgenlib maclib b dsn sys1 agenlib
global maclib osgenlib
```

   These commands can be placed into a CMS EXEC and given control by use of a single command. For details about creating EXEC procedures, refer to the VM/370 CMS User's Guide.

2. The CMS assembler requires two special input files:

   - One CMS file to contain the job control statements that precede the system generation macro instructions. File it with a unique filename, such as STG1IN OJCL.

   - One CMS file to contain: the system generation macro instructions, an END statement, and a /* card. File it with a unique filename, such as STG1IN, and the required filetype of ASSEMBLE. (The filetype identifies it as an assembler source statement file.)

Stage I Execution

With both requirements in step 2 met, assemble the stage I input in the CMS virtual machine by issuing the CMS command:

```
assemble stg1in
```

The assembly output is these two CMS files:

```
STG1IN TEXT     (punch output)
STG1IN LISTING  (printer output)
```

The punched output is the job stream for stage II input. The printed output documents the expansion of each specified macro instruction including the punch statements that comprise the input to stage II.

When assembling under CMS, CMS displays assembly errors on the terminal. A user does not have to wait for the listing to be printed. Before retrying the assembly, use the CMS editor to correct the source file. When the assembly is finally error-free, the two output files which reflect the final assembly can then be printed, punched, or used to create job streams.

Stage I Execution in the OS/VS Virtual Machine

To punch the required job stream for stage I execution to the OS/VS machine's virtual card reader, enter the following commands:

```
cp spool punch to osvssys cont
punch stg1in ojcl (noheader)
punch stg1in assemble (noheader)
cp spool punch nocont
cp close punch
```

By using the CONT operand in the SPOOL PUNCH command, a user concatenates multiple CMS files into one punch output file.

If, at the OS/VS machine, a user enters this CP command before executing stage I:

```
#cp spool punch to oscms
```

and subsequently enters:

```
#cp close punch
```

VM/370 transfers the stage I output to the OSCMS virtual card reader. At the OSCMS terminal, issue this command:

```
readcard stg1in text
```

This CMS file corresponds to the punched output of the stage I assembly (STG1IN TEXT) performed in the OSCMS machine. VM/370 directs the assembly listing, output, in the absence of any printer spooling changes, to the real printer.

STAGE II PROCESSING

The stage I output is a job stream that contains a number of individual jobs. These jobs set up system data sets, assemble nucleus modules, and copy modules from the distribution libraries to the new system residence volume.

Preparing Stage II Input

If the three object module utility data sets used by the assembler during stage II have not been allocated and cataloged, a user can do this by creating the appropriate job stream as a CMS file. Give it a unique filename, such as STG2IN DSALLOC.

To transfer the stage II input to the OS/VS machine, issue these commands:

```
cp spool punch to osvssys cont
punch stg2in dsalloc (noheader)
punch stg1in text (noheader)
cp spool punch nocont
cp close punch
```

Stage II Execution

Process the stage II input job stream on the OSVSSYS virtual machine. Tc enhance this virtual machine's performance, use the various VM/370 performance options, such as running in the virtual=real area and using favored execution with a guaranteed percentage of processor time.

While the OSCMS virtual machine is not directly involved in the stage II processing, it can be used to subdivide the stage I output into individual job streams. This subdividing may make it easier to restart stage II, if necessary.

FINAL HOUSEKEEPING

The new system residence volume now contains the new system control program. Add program products in separate runs by following the procedures contained in the appropriate program product publications. Use the OSCMS virtual machine to set up or modify job streams used to test programs, even if these program aren't part of the installation verification procedure supplied with the system control program.

Sample OS/VS Directory Entries

The following directory entries represent some batch type virtual machines that can be used to run production jobs under OS and OS/VS. The operands specified on the OPTION control statements reflect the requirements of the particular system being used. Disk space can either be dedicated or shared with other systems.

An MFT Virtual Machine

```
USER OSUSER PASSWORD 512K
     ACCOUNT ACCTNO BIN5
     IPL 230
     OPTION REALTIMER ISAM
          CONSOLE 01F 3215
          SPOOL 00C 2540 R
          SPOOL 00D 2540 P
          SPOOL 00E 1403
          DEDICATE 230 OSRES
          DEDICATE 231 OSWRK
          DEDICATE 185 285
          DEDICATE 186 286
```

A VS1 Virtual Machine

```
USER OSVUSER1 PASSWORD 512K
     ACCOUNT ACCTNO BIN6
     IPL 350
     OPTION REALTIMER VIRT=REAL ECMODE
          CONSOLE 01F 3215
          SPOOL 00C 2540 R
          SPOOL 00D 2540 P
          SPOOL 00E 1403
          SPOOL 012 3505
          SPOOL 002 3211
          LINK VMSYS 190 190 RR
          MDISK 191 3330  21  10 UDISKA WR RPASS WPASS
          MDISK 350 3330   0 100 VOSDOS MW
          MDISK 351 3330  51  50 UDISK1 W
```

Another VS1 Virtual Machine

```
USER OSVUSER2 PASSWORD 512K
     ACCOUNT ACCTNO BIN7
     IPL 350
     OPTION REALTIMER ECMODE ISAM
          CONSOLE 01F 3215
          SPOOL 00C 2540 R
          SPOOL 00D 2540 P
          SPOOL 002 3211
          LINK VMSYS 190 190 RR
          MDISK 191 3330  31  10 UDISKA WR RPASS WPASS
          LINK OSVUSER1 350 350 MW
          MDISK 351 3330   0  50 UDISK3 W
```

An MVS Virtual Machine (for running test jobs only)

```
USER MVSVIRT PASSWORD 4M 8M G
     ACCOUNT ACCTNO BIN7
     IPL CMS
     OPTION ECMODE ISAM BM
          CONSOLE 01F 3215
          SPOOL 00C 2540 R
          SPOOL 00D 2540 P
          SPOOL 00E 1403
          SPOOL 00F 1403
          MDISK 191 3350 544 005 VMS005 MW PASSWORD
          LINK COMMON 190 190 RR
          LINK COMMON 191 19E RR
```

Another MVS Virtual Machine (for running test jobs only)

```
USER MVSID PASSWORD 3M 16M BCG
     ACCOUNT ACCTNO BIN8
     IPL CMS
     OPTION REALTIMER ECMODE BM
          CONSOLE 01F 1052
          SPOOL 01C 2540 READ A
          SPOOL 01D 2540 PUNC A
          SPOOL 007 3211      A
          SPOOL 008 3211      A
          SPOOL 017 3211      A
          SPOOL 018 3211      A
          SPOOL 01E 1403      A
          SPECIAL 2FF 3270
          SPECIAL 0FF TIMER
     (This entry then uses the MVS
     machine's PROFILE EXEC to attach
     the appropriate volumes and IPL MVS.)
```

Accessing OS/VS

This topic assumes that OS/VS for use under VM/370 has already been generated and that the system residence volume is available on a real disk or minidisk in read/write status.

As the OS/VS operator, the OS/VS user needs to know the location of the system residence volume. Its location can be defined in the virtual machine configuration in one of three ways:

- Define the system residence volume as a read/write disk in the directory entry for the OSVS userid. Such a definition may appear as follows:

  ```
  MDISK 250 3330 0 403 VS2RES WR YOUR NAME
  ```

  Many installations prefer this approach for maintaining a directory definition of the system residence volume.

- Use the CP LINK command to define the system ressidence volume after logon. For example: If the SVS or MVS system programmer "owns" the system residence volume and keeps it in his virtual machine at virtual address 150, the OSVS user could gain access to it with this CP command:

  ```
  link vs2sysp 150 250 w [name]1
  ```

  In this command VS2SYSP is the programmer's userid, and NAME is the write password.

---

[1] If an installation is using password-on-the-command-line suppression, a user cannot specify the password on the same command line. Passwords must be entered in such a way that they are either not displayed on display terminals or typed upon a mask for typewriter terminals.

- Have VM/370 system operator (or any class B user) exclusively attach the entire system residence volume to the OSVS userid by issuing this command:

  ```
  attach 152 to osvs as 250
  ```

  In this command, 152 is the real device address on which the system residence volume is mounted.

Using Virtual Devices

When using OS/VS in a virtual machine, the user is the OS/VS operator. This user must have the following devices, which are normally defined in the VM/370 directory entry:

- A virtual card reader, from which OS/VS reads the OS/VS input job stream.
- A virtual printer, which handles the printed output generated by OS/VS.
- The virtual punch, which receives punched output generated during OS/VS operation.

In addition to these unit record devices, the OS/VS operator can attach virtual tape and direct access storage devices to the virtual machine (by using either the ATTACH or DEFINE commands). The user can also specify these devices in the VM/370 directory entry.

Depending upon how OS/VS was generated, a user may need to change a virtual device address. For example: If OS/VS expects a 3211 printer at device address 002 and the directory entry does not contain this assignment, define one with the CP DEFINE command:

```
define 3211 002
```

Before using OS/VS, find out from the OS/VS system programmer what are the installation's virtual device requirements.

DEFINING THE OPERATOR'S CONSOLE

The operator's console must be at the address specified during OS/VS system generation. The easiest way to ensure this is to define the appropriate console address in the directory entry. For example: The CONSOLE directory control statement could appear as follows:

```
CONSOLE 01F 3210
```

This statement defines a virtual 3210 console at virtual address 01F.

A user should let the VM/370 spool file system handle printer or punch output that does not have to be printed or punched. For example: When using the alternating technique, route print output to the virtual card reader by using this CP SPOOL command:

```
#cp spool printer to *
```

After issuing this command, a user can subsequently load the CMS system and create a CMS file from the data in the virtual reader (by using the CMS READCARD command). Then, by using the CMS editor, the user can scan the contents of this data at his terminal.

Preparing Jobs for an OS/VS Virtual Machine

Prepare and submit a job stream to an OS/VS virtual machine in one of two ways:

- Place a deck of real punched cards that contain the appropriate job control, program and data in the real card reader. Place a CP ID statement at the beginning of this job stream deck to indicate the OS/VS userid; for example:

  ```
  ID OSVS

  -- or --

  USERID OSVS
  ```

  Either statement is a valid ID statement for directing the input that follows to the OSVS user's virtual reader (the reader with the lowest virtual device address).

- Use the CMS system to create a CMS file containing images of what would normally be submitted through a card reader on a real System/370. Enter the CP SPOOL command to cause subsequent punched output to be directed to the virtual card reader of the OS/VS machine. Enter the CMS PUNCH command to generate the virtual card deck:

  ```
  cp spool punch to osvs
  punch vsjob27 jcl (noheader
  ```

  The NOHEADER option of the PUNCH command suppresses punching a CMS READ control card at the beginning of the deck.

A job stream spooled to OS/VS by either of these methods remains in the card reader of the OS/VS virtual machine until the user starts an OS/VS reader.

When spooling jobs to a virtual machine, clear any data that may remain in the virtual punch from previous jobs by issuing these CP commands:

```
cp spool punch nocont
cp close punch purge
```

These commands ensure that the virtual punch is purged of any existing reader files. The first command is required if the punch had been originally spooled with the CONT operand.

When running OS/VS in a virtual machine, a primary consideration is job entry and output retrieval. Several techniques can be used for these functions:

- Use the OS/VS virtual machine in batch mode where it operates as OS/VS in native mode. It reads in job streams through a dedicated card reader and prints output generated by the virtual machine on a dedicated printer.
- A single directory entry (userid) can contain a configuration sufficient for running both CMS and OS/VS (the alternating technique). Load CMS to create and edit OS/VS job streams and to check the OS/VS output. Load OS/VS to run the OS/VS job streams.
- Use two different userids to keep two virtual machines running. (This is the optimum environment.) Use one userid for the OS/VS machine while using the other for a CMS machine to create job streams and inspect output. By using the CP DISCONN command, users can run both virtual machines from the same terminal. Thus, both machines are running concurrently, but a user communicates with only one at a time. If two terminals are available, each system can run independently of the other.

Loading OS/VS

At logon, use the userid for running OS/VS. It may be a user's own userid when running alternating or concurrent systems. It may be a special userid that an installation has set aside exclusively for the OS/VS machine.

```
logon osvs
```

Because extended control (EC) mode is required to operate OS/VS, the directory entry should contain the ECMODE specification on the OPTION control statement. If it is not included, enter this CP command to enable extended control mode simulation:

```
set ecmode on
```

Note: To run OS/PCP and OS/MFT, a user does not need the ECMODE option. To run OS/MVT, a user does not need the ECMODE option unless running the generalized trace facility (GTF) under OS/MVT. However, OS/PCP, OS/MFT, and OS/MVT normally required the REALTIMER option.

At this point, between logging on and loading the operating system, a user may find it desirable or necessary to alter the virtual machine's storage size. For example: If the directory entry specifies 1 megabyte of storage and a user needs 2 megabytes for this particular terminal session, issue the CP DEFINE command:

```
define storage as 2m
```

Virtual machine storage can be redefined up to the limit set in the USER control statement of the directory entry.

Once the IPL volume is made available, enter this command to load OS/VS:

```
ipl 250
```

OS/VS responds with a "SPECIFY SYSTEM PARAMETERS" message. The proper use of a system parameter list (IEASYS00 or IEASYSxx), created during or subsequent to the OS/VS system generation process, can result in a significant saving of time. Commonly used operator commands can be placed in the SYS1.PARMLIB data set to shorten the IPL process.

OS/VS Operation

To control OS/VS, use OS/VS operator commands to hold and release queues and jobs and to start initiators or define partitions. Users can observe the progress of the command's execution by following the OS/VS messages. Figure 18 shows how VM/370 loads VS1 in a virtual machine.

```
LOGON AT 01:96:14 EST WEDNESDAY 10/29/75
def stor 3072k
STORAGE = 03072K
q set
MSG ON , WNG ON , EMSG TEXT , ACNT ON , RUN OFF
LINEDIT ON , TIMER REAL , ISAM OFF , ECMODE ON
ASSIST ON SVC , PAGEX OFF , AUTOPOLL OFF
IMSG ON , AFFINITY OFF
def 009 01f
CONS 01F DEFINED
q chan
CHANNELS = SEL
def chan bmx
CHANNELS = BMX
     The virtual selector channels have been redefined
     to block multiplexer. This is a performance
     consideration to improve the processing of I/O
     operations.  To avoid issuing the CP DEFINE BMX
     command, the VM/370 directory entry can specify
     the BMX option in the OPTION control statement.
i 250
IEA760A SPECIFY VIRTUAL STORAGE SIZE
r 00,'3072'
     Specifying the size of the virtual machine's
     storage relative to the VS1 virtual storage
     size is a performance consideration. VS1 has
     been shown (in performance studies) to operate
     more efficiently in a virtual environment if it
     is not forced to do any of its own paging.
     Also, in nonpaging mode VS1 avoids many
     privileged instructions, thereby reducing
     VM/370 overhead.
       To force VS1 into a nonpaging mode, use VM/VS
     handshaking and define the storage size for the
     virtual machine equal to the virtual storage
     size requested by VS1.
IEA788I NON-PAGING MODE OF VS UNDER VM/370
IEE054I DATE=75.300,CLOCK=009.00.00
IEE054I DATE=75.300,CLOCK=009.00.02,GMT
IEA764I NIPNULL,CMDMON,DFNPARM,JESNULL,,,,SETPARM,,
IEA101A SPECIFY SYSTEM AND/OR SET PARAMETERS FOR RELEASE 04.0 OS/VS1
r 00,'u'
IEA106I IEAAPF00 NOT FOUND IN SYS1.PARMLIB
```

Figure 18. Sample IPL of VS1 under VM/370 (Part 1 of 2)

```
IEE140I SYSTEM CONSOLES
   CONSOLE/ALT COMD AUTH     ID       ROUTCP
     01F/01F    M   ALL      01       1-10,10-16
IEF031I SYSGEN VALUES TAKEN FOR JES
IEF866I DEFINE COMMAND BEING PROCESSED
IEE804I PO=(C=AOB,576'K,A,I),P1=(C=AOB,576K,A,E,LAST),
IEE804I P2=(INACTIVE),P3=(INACTIVE),
IEE804I P4=(INACTIVE),P5=(INACTIVE),
IEE804I P6=(INACTIVE),P7=(INACTIVE),
IEE543I 250K BYTES FREE SPACE
IEE817I TMSL=NONE
IEE805I DEFINITION COMPLETED
IEE101A READY
IEE009I JLPRM=(U)
IEE050I MN JOBNAMES,T
IEE048I INITIALIZATION COMPLETED -
```

Figure 18. Sample IPL of VS1 under VM/370 (Part 2 of 2)

When using CMS, initial operator commands can be incorporated into a CMS EXEC procedure as part of the job stream. For example: To create the following EXEC procedure called SETUPVS, issue these commands:

```
CP LINK VSSYS 250 250 RR OSPASS
CP DEFINE 009 AS 01F
CP IPL 250
```

After starting the appropriate OS/VS readers, the virtual machine is ready to receive input from card readers, DASD, or tape drives.

COMMUNICATING WITH CP

During OS/VS virtual machine operation, a user can issue CP commands to (1) communicate with the VM/370 system operator or other virtual machine users, and (2) query and alter the status of the configuration and spool files. In general, a user can enter any of the CP commands normally permitted under his userid's privilege class.

Entering CP commands while an OS/VS virtual machine is running depends on the terminal mode (as defined by the CP TERMINAL command or its default value). When not running as the VM/370 system operator, the default terminal mode is VM. In this mode, pressing the attention key (or its equivalent) once passes an interruption pending condition to the OS/VS virtual machine. Pressing the attention key twice places the virtual machine in the CP command environment from which CP commands can be entered. For a complete description about how to use the attention key, refer to VM/370 CP Command Reference for General Users.

Using the #CP Function

In most cases during virtual machine operation, a user can use the #CP function to enter CP commands directly from the virtual machine. If the virtual machine has issued a read to the terminal, enter a CP command with the #CP function. For example: When no longer using virtual tape drive 397 mapped to real tape drive 492, issue:

```
#cp detach 397
#cp msg cp i am done with real drive 492
```

VM/370 immediately processes these command lines, and the virtual machine read remains outstanding.

Note: A user may not always be able to enter CP commands with the #CP function. The read issued by OS/VS at the terminal must be for at least as many bytes as entered in the #CP command line; any additional information is truncated. If the read is for at least three bytes, enter the #CP command. This command places the user in CP command mode from which CP commands can be entered directly. To return to the virtual machine environment, enter the BEGIN command.

Using OS/VS in Batch Mode Under VM/370

When many users submit jobs to a single OS/VS virtual machine, someone is generally needed to tend the machine as an operator. The virtual machine operator must make those decisions required of an operator on a real machine; that is, deciding what work is going to be done and what is the most efficient way of doing it.

In batch mode, one user runs as the OS/VS machine (userid OSVS) and other users (like CMSID1) may submit jobs either through the virtual card reader, through the system card reader, or through JES remote stations. If the card reader is not dedicated to the OS/VS virtual machine, place an ID card at the beginning of each job stream, such as:

```
USERID OSVS A
```

In this card: the USERID (or ID) indicates the valid beginning of an ID card, OSVS is the name of the VM/370 user to receive the card input in his virtual reader, and A is the VM/370 reader class.

Note: If the VM/370 system operator has dedicated a card reader to the OS/VS virtual machine, then the ID card must be omitted at the beginning of the deck.

A user can send jobs to the OS/VS machine from other virtual machines by spooling his punch to the OS/VS userid, such as:

```
#cp spool punch to osvs
```

Entering this statement causes subsequent punched output to appear in the virtual card reader for userid OSVS.

Alternating Between CMS and OS/VS Under VM/370

When working in a program development environment (rather than a production environment) and unable to test programs directly under CMS, a user can alternate between OS/VS and CMS in a single virtual machine. Some advantages of this technique (described in this topic) are:

- Reduced unit record output. Users can examine program output and compiler listings online, check the results, and resubmit the job without producing any output on the system unit record devices.
- Faster turnaround time (generally) than in a batch environment.

Before using this technique, users should be familiar with the CMS editor and CMS file manipulation commands found in the VM/370 CMS User's Guide.

LOADING CMS INTO A VIRTUAL MACHINE

To load CMS into a virtual machine, use the CP IPL command and specify either a saved system name or a device address:

```
ipl cms

-- or --

ipl 190
```

When CMS responds with a message like this:

```
CMS VERSION 3.0
```

Enter the CMS commands to create an OS/VS job stream.

USING THE CMS EDITOR TO PREPARE JOB STREAMS

The following CMS procedure creates an OS/VS job stream that can be passed to the OS/VS virtual machine's reader. It shows how to compile a PL/I program under OS/VS, making the PL/I source file available as a CMS file called PLI27 DECK.

```
edit pli127 jcl                          open a CMS file by name
input                                    go into input mode
//pli127 job cps,fred,msglevel=1         enter jcl entries
//cat exec plifc                         |
//sysin dd *                             V
(null line)                              return to edit mode
getfile pli127 deck                      copy over PL/I source file
input                                    go into input mode
/*                                       enter jcl entries
//                                       V
(null line)                              return to edit mode
file                                     write the file to disk
```

ISSUING SPOOL COMMANDS TO CONTROL UNIT RECORD DEVICES

Spool the virtual punch to the virtual machine:

```
cp spool punch to *
```

This command causes subsequent punched output to appear in the user's own virtual card reader. To submit a job to the OS/VS machine, punch the JCL and associated card data.

Spool the virtual printer to the virtual card reader:

```
cp spool printer to *
```

Instead of routing printed output to the real printer, this command causes it to appear in the virtual card reader. By using the CMS machine, each print file can then be read, examined, and either purged or printed at the real printer.

Note: Since a user may find both punch and printer files in the virtual reader, consider using the spool file class attribute to control which files are to be processed at any one time.

PUNCHING CMS FILES

Use the CMS PUNCH command to transfer the job stream to the virtual card reader of the OS/VS virtual machine:

```
punch pli27 job (noheader
```

By specifying NOHEADER option of the PUNCH command, VM/370 does not punch a CMS READ control card at the beginning of the output deck.

INIZIALIZING OS/VS

Lcad OS/VS into the virtual machine by issuing this command:

```
cp ipl 250
```

When an OS/VS reader is started, it reads the job stream that had been previously punched with the punch spooled to the user's own userid. For example, the OS/VS command:

```
s rdr,00c
```

starts a reader on virtual device 00C and reads those cards that appear in the OS/VS reader queue.

RELOADING CMS INTO A VIRTUAL MACHINE

When the job stream has been processed, reload CMS and use the READCARD command to create a CMS file from the printed output and put it onto a CMS disk. The output can now be examined with the CMS editor or TYPE command. When hardcopy output is needed, the file can be printed via the CMS PRINT command. When using the READCARD command to create a CMS file, do not use a filetype of LISTING. Otherwise, VM/370 assumes the first character of each line to be a control character, which is not printed.

EXAMINING OS/VS VIRTUAL MACHINE OUTPUT

To examine a job's output executed under the OS/VS virtual machine, spool the unit record output to the user's own userid. Now read the file in the virtual card reader onto a CMS disk by using CMS READCARD command:

```
readcard pli27 job
```

The CMS TYPE command or editor can then be used to scan such a file.

If programming errors occurred during the execution of the job stream, the CMS editor can be used to make corrections to the source program, correct job control statements, or resolve any other execution problems. After making these corrections, resubmit the job stream.

Using More than One Virtual Machine

A user can run multiple systems, each in its own virtual machine and each controlled from its own terminal. However, if multiple terminals are not available, a user can use one terminal to control all systems but only one at any one time.

This approach combines the alternating system and batch techniques. Separate userids are used to run OS/VS in one virtual machine and to prepare jobs and examine OS/VS output in a CMS virtual machine.

After submitting a job stream under the CMS userid, issue the DISCONN or LOGOFF command (depending upon how soon the user intends to log onto the CMS ID again). The terminal is now free to be used for running the OS/VS job stream under the OSVS userid:

```
logon cmsid
.
.
.
(route jobs to OSVS user)
.
.
.
disconn
logon osvs
.
.
.
(run jobs)
```

The procedures for running with two virtual machines are much the same as those used in running a single virtual machine in alternating mode. The primary difference is that a user now spools the virtual punch and printer to the other virtual machine instead of spooling them to the user's own userid:

```
logon cmsid
sp pun osvs
.
. (route jobs to OSVS user)
.
disconn
logon osvs
#cp sp prt cmsid
#cp sp pun cmsid
.
. (run OS/VS jobs)
.
```

DISCONNECTION CONSIDERATIONS

When using more than one userid to alternate communications between operating systems, consider:

- How OS/VS may read additional jobs from the card reader?
- What happens when a read is issued at the disconnected OS/VS virtual console?
- What happens to the console output of the disconnected virtual machine?

Sending Jobs to a Disconnected OS/VS Machine

When using CMS to route jobs to a disconnected OS/VS virtual machine, spool the OS/VS reader with the CONT operand of the CP SPOOL command:

```
spool reader cont
```

This command allows the OS/VS reader to read more than a single job at a time without operator intervention.

When a Console Read Occurs in a Disconnected OS/VS Machine

When running OS/VS disconnected, a 15-minute time-out begins when a console read occurs. If the read does not occur within the 15 minutes, VM/370 automatically logs off the virtual machine.

Whenever running OS/VS disconnected, it is suggested that a console log be created. This log provides a user with a history of what jobs were run. It can also indicate any unusual circumstances that occurred during the terminal session.

To start console spooling, issue:

```
spool cons start
```

To stop console spooling and to print the log, issue:

```
spool console stop close
```

Console Output for a Disconnected Virtual Machine

When a virtual machine is running disconnected, all console output is lost unless a user initiates console spooling, such as by issuing:

```
#cp spool console start
```

Spooling of the console output continues until a user either logs off or issues:

```
#cp spool console stop
```

Disconnecting the virtual machine does not stop console spooling. Therefore, the spooled console log for a terminal session, punctuated with several disconnects, consists of one uninterrupted printer file.

Developing and Testing Programs to Run in an OS/VS Virtual Machine

The previous discussions demonstrated how the CMS editor and EXEC facility can help a user prepare jobs for execution in an OS/VS virtual machine. In addition to these CMS functions, there are a number of other CMS commands for developing and testing programs.

For example: A user can use the CMS READCARD and MOVEFILE commands to create CMS files from source programs or existing JCL that are on cards or magnetic tape. One advantage of storing source programs on CMS disks is that they can be maintained as backup copies of a program while a second version is being tested and debugged. By using the CMS editor or commands like COPYFILE, SORT, and RENAME, a user can modify and copy CMS disk files.

Refer to VM/370 CMS User's Guide for information on how to compile and execute many types of OS/VS programs under CMS.

OS/VS2 MVS Uniprocessor Under VM/370

When operating MVS in uniprocessor mode under VM/370, VM/370 simulates three privileged and two nonprivileged System/370 instructions.

The three privileged instructions are:

```
CLRIO (clear I/O)
IPK (insert PSW key)
SPKA (set PSW key from address)
```

The two nonprivileged instructions are:

CS (compare and swap)
CDS (compare double and swap)

VM/370 allows the compare instructions (CS and CDS) to execute normally; that is, it does not simulate them when the real machine is equipped with the appropriate hardware feature. However, when MVS is run under VM/370 on a machine that does not have these instructions installed, VM/370 simulates them.

Summary

When loading OS/VS into a virtual machine, the terminal becomes the OS/VS operator console, and the virtual machine user becomes the operator responsible for entering all commands and responses. The three basic techniques for running OS/VS in a virtual machine are: batch mode, alternating between OS/VS and CMS in a single virtual machine, and (for OS/VS2 users only) running OS/VS2 disconnected.

Before using one of these techniques, an installation must understand how to:

- Generate OS/VS to run in a virtual machine
- Create VM/370 directory entries for OS/VS virtual machines
- Access the OS/VS system residence volume
- Ensure that the proper I/O devices are attached to the OS/VS virtual machine
- IPL and operate OS/VS under VM/370

The primary objectives when generating OS/VS to run in a virtual machine should be to have all commonly used transient routines resident in storage and to run all jobs V=R if possible. To meet these objectives, an installation needs to consider how it generates both VM/370 and OS/VS. (OS/VS can also be generated under VM/370.)

To control OS/VS in a virtual machine, use OS/VS operator commands to hold and release queues and jobs, and to start initiators or define partitions. Users can observe the progress of the command's execution by following the OS/VS messages. Also, additional operator commands and control statements must be entered at the console before running jobs on the OS/VS virtual machine.

OS/VS virtual machine users can use the CMS editor and the EXEC facility to prepare jobs for execution in an OS/VS virtual machine. They can also use CMS commands to develop and test programs on CMS disks.

Index

The entries in this Index are accumulative. They list additions to this publication by the following VM/370 System Control Program Products:

- VM/370 Basic System Extensions, Program Number 5748-XX8
- VM/370 System Extensions, Program Number 5748-XE1

However, the text within the publication is not accumulative; it only relates to the one SCP program product that is installed on your system. Therefore, there may be topics and references listed in this Index that are not contained in the body of this publication.

IBM VM/370 Operating Systems
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IBM Virtual Machine Facility/370: Operating Systems in a Virtual Machine

This Technical Newsletter contains replacement pages for VM/370 Operating Systems in a Virtual Machine to support Release 6 PLC 17 of IBM Virtual Machine Facility/370.

Before inserting any of the attached pages into the VM/370 Operating Systems in a Virtual Machine, read carefully the instructions on this cover. They indicate when and how you should insert pages.

Pages to be Removed	Attached Pages to be Inserted*
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*If you are inserting pages from different Newsletters/Supplements and identical page numbers are involved, always use the pages with the latest date (shown in the slug at the top of the page). The page with the latest date contains the most complete information.

Changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

Summary of Amendments

This Technical Newsletter incorporates changes reflecting minor technical and editorial changes.

Note: Please file this cover letter at the back of the publication to provide a record of changes.

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