

The presentation cover features a vertical column of overlapping circles in shades of blue, green, yellow, and red on the left side. A QR code is located in the lower-left quadrant. The title 'Introduction to z/VM: Through the Looking Glass' is centered in a large, blue, sans-serif font. Below the title, the presenter's name 'Sam Cohen' and affiliation 'Levi, Ray & Shoup, Inc.' are listed. The date 'March 10, 2014' and session number 'Session Number 14521' are also provided. In the top right corner, there is a Twitter logo with the hashtag #SHAREorg and a logo for SHARE (Sharing Analytics Resources for Enterprise). In the bottom right corner, the SHARE logo is repeated with the text 'in Anaheim'. A geometric, wireframe-like structure resembling a crystal ball or a complex network is positioned on the right side of the cover.

**Introduction to z/VM:
Through the Looking Glass**

Sam Cohen
Levi, Ray & Shoup, Inc.

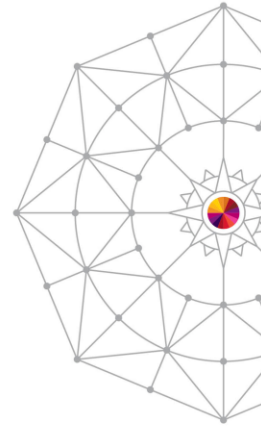
March 10, 2014
Session Number 14521

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This presentation is designed to present an overview of z/VM to z/OS and Unix/Linux-oriented systems programmers. The presenter is assumed to be well versed in z/VM concepts and terminology, and should be able to understand terms and concepts of z/OS and Linux.


Agenda

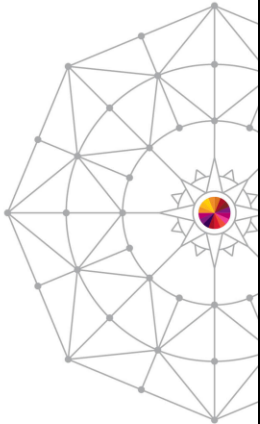
- Computing Resource Responsibilities
- z/VM Concepts
- z/VM Components
- CMS Filesystems
- Common CP/CMS Commands
- More Detailed Topics
- Linux Considerations under z/VM




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Computing Resource Responsibilities

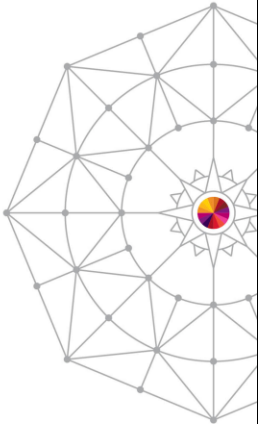





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The Responsibilities of a Systems Programmer




- Allocation of Computing Resources
 - CPU
 - Memory
 - Disk
 - Network/File Access
 - Etc
- Management of Computing Resources
 - Capacity Planning
 - Performance Management
 - Availability Management
 - Problem Determination/Problem Source Identification (PD/PSI)
 - others

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Let's consider the unique roles of the Systems Programmer vs. the Computing Resource End User. Basically, the Systems Programmer allocates and manages Computing Resources (CPU, Memory, Disk space, Network Access, etc)




The Responsibilities of the User

Determine and Communicate the Computing Resources Required

- CPU
- Memory
- Disk
- File/Network Access
- etc.

Communicate the Systems Management Requirements

- Backup/Recovery
- Changes to the Environment
- Performance Characteristics
 - “As Fast as Possible” isn’t a Performance Characteristic
- Availability
 - Is 24/7/365 a real requirement?




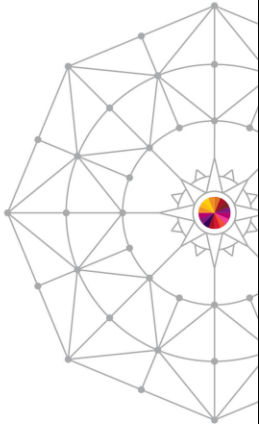
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This User, in this case, is not the end-user like a client running a web browser connecting to a server. This User is the content creator for the server. The End User of a Computing Resource not only creates the application programs, but must communicate to the Systems Programmer the amount of resources required.


One common difficulty for the User in the zSeries environment is the requirement to understand availability and performance requirements by the end-user community. These requirements are often not considered in the xSeries or pSeries environments until after the application has been developed.

z/VM Concept








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z/VM Concept

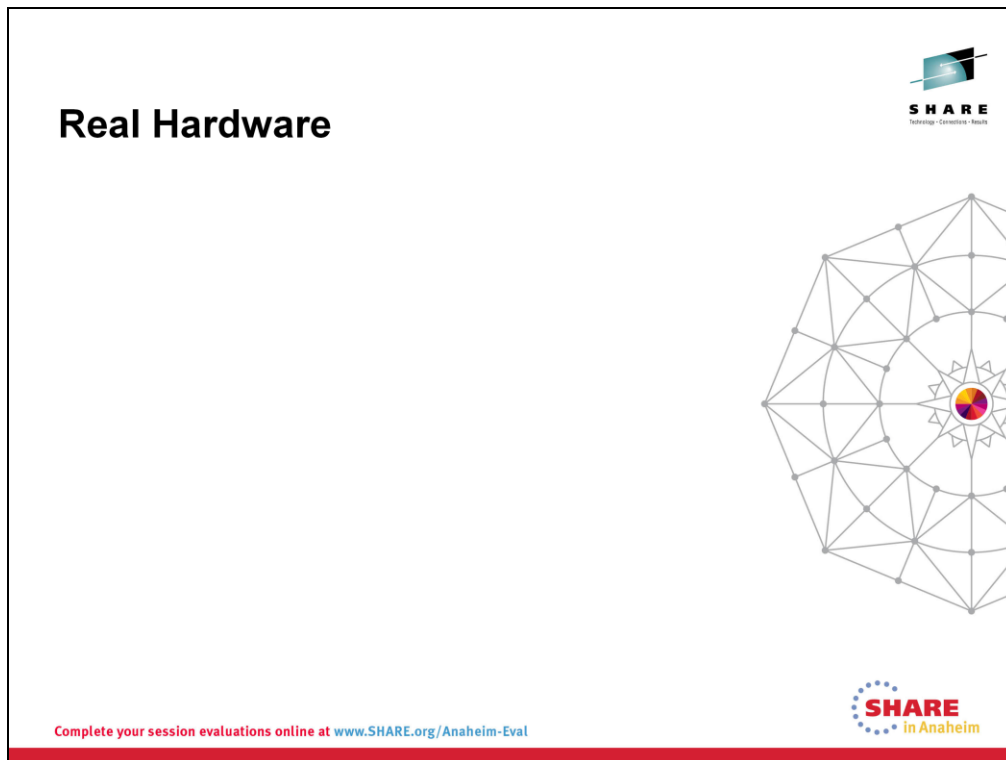
- z/VM Provides for the Definition and Management of Virtual Computers
 - Management of Real Hardware in support of Virtual Machines (“users” in z/VM terminology)
 - Definition of Virtualized Hardware
 - Allocation of Dedicated Real Hardware
 - Sharing of Real Hardware
 - Allocation of Dedicated Virtual Hardware
 - Sharing of Virtual Hardware
 - A Virtual Machine has only virtual hardware



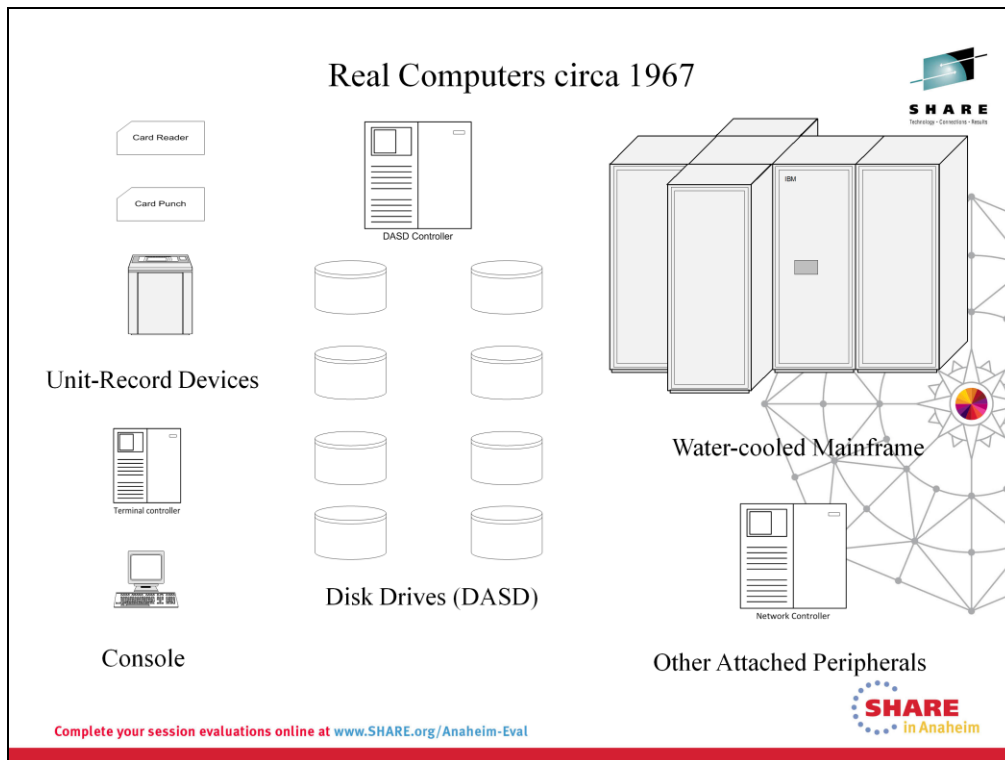
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Although a Virtual Machine uses real computer resources, it has no idea what the “real” world looks like, only what it can see. Everything in a virtual machine looks real to the guest operating system.

A Virtual Machine uses real hardware resources, but even with dedicated devices (like a tape drive), the virtual address of the tape drive may or may not be the same as the real address of the tape drive. Hence, a virtual machine only knows virtual hardware that may or may not exist in the real world.




z/VM has its roots in a laboratory project that “escaped” and was known as CP67. Its paradigm, like that of the zSeries, harkens to computers and concepts from the S/360 and S/370 days.



So, what made up a computer in 1967? A computer had:


- 1) A Water-Cooled mainframe computer, with a certain amount of memory (also known as Central Storage)
- 2) Unit-Record Devices...card reader, card punch and line printer
- 3) A console for interfacing with the computer
- 4) Drum or disk drives (known as Direct Access Storage Devices or DASD)
- 5) Other devices attached via channel cables


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Virtualized Hardware via CP

CP (Control Program)

- Is one of z/VM's component
- Creates virtual computing resources for a virtual machine
- Manages real hardware in support of those virtual computing resources



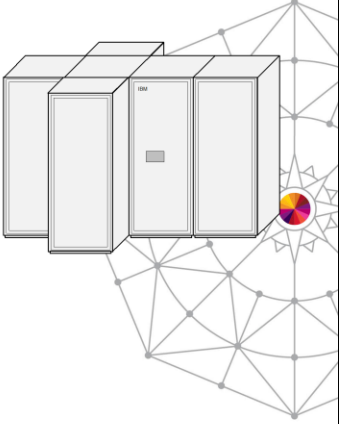
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CP is the main focus in this presentation. Its job is to manage hardware (real or virtual) and virtual machines.

Virtual CPU

- CP can dedicate real CPU or share CPU between virtual machines
- CP can present more virtual CPUs than really exist
- Virtual CPU is not the same as Logical CPU
 - Physical CPU – the number of actual problem processors on the hardware
 - Logical CPU – the number of problem processors assigned to a Logical Partition
 - Cannot exceed the number of physical CPUs
 - Virtual CPU – the number of problem processors assigned to a Virtual Machine



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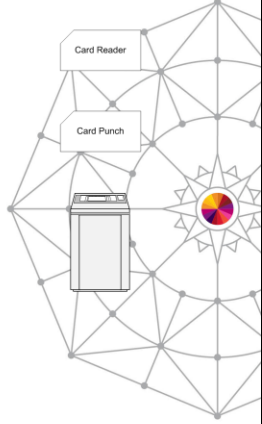
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This series of charts show how CP takes its knowledge of real hardware and allows creation of virtual hardware

Unit-Record Devices

- Card Reader, Card Punch and Line Printer are presented to a virtual machine as Spooled Devices
- Real Unit-Record Devices (including tape drives) must be dedicated / attached (to a user or system)



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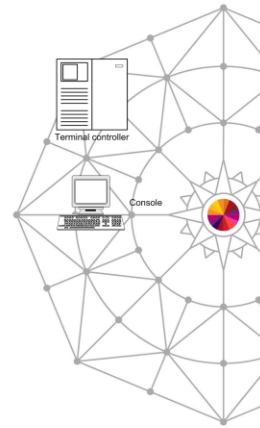
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Did you know that SPOOL is an acronym? Simultaneous Peripheral Operations On-Line

Console Device

- Virtual Console does not have to be physically connected to a real terminal
- If not connected to a real terminal, the virtual machine is considered to be “disconnected”

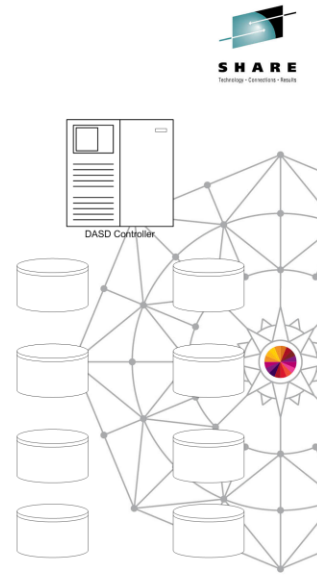


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Disk Devices

- Disk space can be contiguous subsets of physical disk (termed “minidisk”; similar to disk partitions in the x86 world)
- Disk space can also be “virtual storage” – carved out of memory (similar to a PC-DOS RAM Disk)
- Disk space can be on Count-Key-Data (CKD) or Open Systems (SCSI) devices
 - CKD devices have variable-block physical allocation
 - SCSI devices have fixed-block physical allocation
- Minidisks can be shared between multiple virtual machines
- A minidisk cannot span physical disks

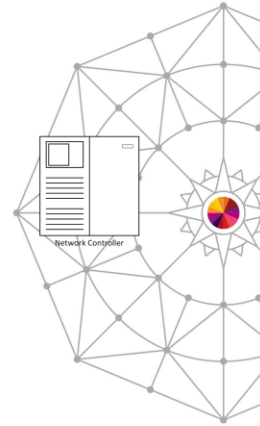


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Other Physical and Virtual Devices

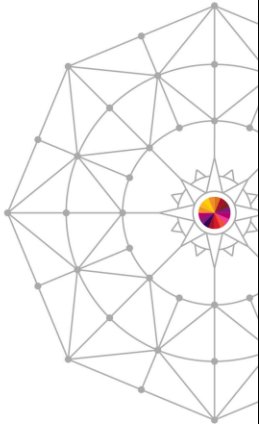

- Examples of other physical Peripherals:
 - Physical connections between LPARs/systems
 - FICON Directors
 - SAN Switches
- Virtual Peripherals
 - CTC (3088/ESCON/FICON), IUCV
 - 3270 and ASCII Terminals (GRAFs)
 - LANs (Hipersockets, QDIO Ethernet)
 - Coupling Facilities and Coupling Links
 - Network Switch (Layer 2 or Layer 3 with VLAN awareness)




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System Definitions



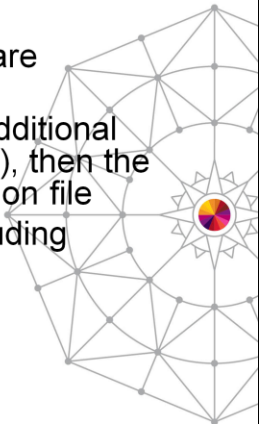


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System Configuration File

- At system startup (IPL), attached devices are scanned and identified automatically
- If a device cannot identify itself or needs additional information (such as printer characteristics), then the device is defined in the System Configuration file
- This file also contains additional data, including
 - Determination of System Name
 - Definitions of virtual hardware
 - Live Guest Relocation information
 - Enablement of optional system features

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The System Configuration File will be referenced in a later chart when IPL of z/VM is discussed

VM Directory



- Defines each virtual machine
 - Identifies initial resource allocations
 - Authorizes certain control commands and info displays
- Created by the DIRECTXA command from source code
- Doesn't care if you overlap disk storage areas – use DIRMAMP/DISKMAP EXECs to map out disk allocations from Directory Source file or use Directory Management tool
- No disassembler!
 - Don't lose your source


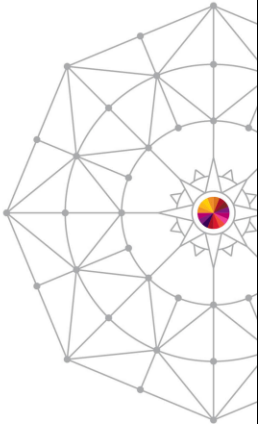



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VM Directory Example


```
PROFILE LNXGUEST
SPOOL 00C READER *
SPOOL 00D PUNCH *
SPOOL 00E PRINTER A
CONSOLE 009 3215 T LNXMAINT
IPL CMS
NICDEF E000 TYPE QDIO LAN SYSTEM VSWITCH1
LINK LNXCMN 191 191 RR
LINK LNXCMN 203 203 RR
LINK LNXCMN 204 204 RR
....
....
USER LINUX1 LINUX1 256M 768M BG
INCLUDE LNXGUEST
SPECIAL F000 CTC TCPIP
SPECIAL F001 CTC TCPIP
MDISK 0200 FB-512 V-DISK 4096 W
MDISK 0201 3390 0001 0250 LNX001 MR
MDISK 0202 3390 0251 1000 LNX001 MR
```



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This example shows a virtual machine setup to run Linux using shared read-only minidisks. These minidisks (contained in the profile) contain executables (such as /boot and /usr) that can be shared between Linux instances and managed centrally.


Note that you can run a complete copy of z/VM in a virtual machine. This is good for testing new releases of z/VM or CP modifications prior to putting them into production



z/VM Components

- Control Program (CP)
- Conversational Monitoring System (CMS)
- Group Control System (GCS)
- Dump Viewing Facility (DVF)
- REXX Procedure Language (REXX)
- VM Serviceability Enhancements – Staged/Enhanced (VMSES/E)
- APPC VM/VTAM Services (AVS)
- Transparent Services Access Facility (TSAF)
- Language Environment (LE)



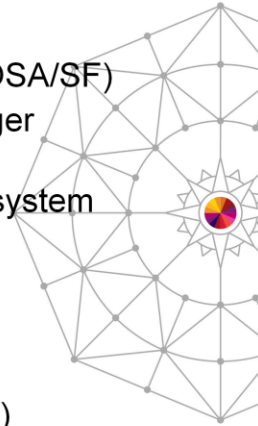


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We've talked about CP. CMS and GCS are operating systems that have a symbiotic relationship with CP and cannot run on their own. The other components are tools/middleware/libraries.

z/VM Components (cont'd)

- TCP/IP
- Open Systems Adapter/Support Facility (OSA/SF)
- Hardware Configuration Definition / Manager (HCD/HCM)
- Remote Spooling & Communications Subsystem (RSCS)
- Directory Maintenance (DIRMaint)
- Resource Access Control Facility (RACF)
- VM Performance Toolkit (PerfTk)
- Extreme Cloud Administration Tool (XCAT)



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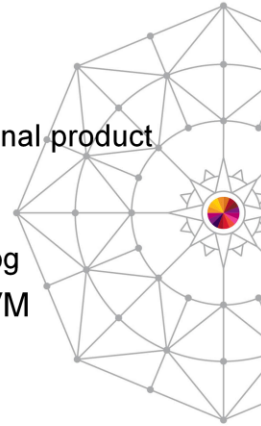


DFSMS/VM is not the same as DFSMS for z/OS. IODF output from z/VM's HCD/HCM is not compatible for use by z/OS guests or z/OS in other LPARs. Note that you do not need to use HCD/HCM...if your real hardware IOCDS is being managed from another LPAR, you can allow z/VM to be fully dynamic in its I/O recognition by using the defaults coded in the SYSTEM CONFIG file.

z/VM Optional Program Products



- Systems Managed Storage (DFSMS/VM)
 - Minidisk Management Utilities
 - Automated Tape Library Interface (APIs)
 - Not pre-installed, must be ordered as optional product with z/VM order, although no-charge
- IBM Tape Manager for z/VM
 - Compatible with DFSMSrmm (z/OS) catalog
- IBM Backup and Restore Manager for z/VM
- High-Level Assembler
 - Required for RACF Tailoring
- Others






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Additional Optional Program Products may be available; see <http://www.vm.ibm.com>

Conversational Monitoring System (CMS)

- Interactive Operating System for z/VM
- Originally single-tasking, now multi-tasking
- Often used to setup environment for guest operating systems (like Linux)
 - Define/establish communication paths
 - Change virtual machine settings
 - Define/configure additional virtual resources


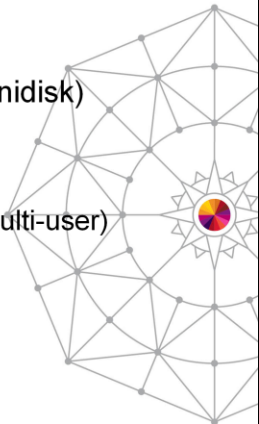



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This set of charts discusses CMS and its filesystems

CMS Filesystems

- Minidisk (original filesystem for CMS)
 - Explicitly defined portion of a physical disk (minidisk)
 - Cannot span physical disks
 - Access control at disk level
 - Based on Directory Entry
 - By knowledge of access password (read/write/multi-user)
 - Record-Oriented


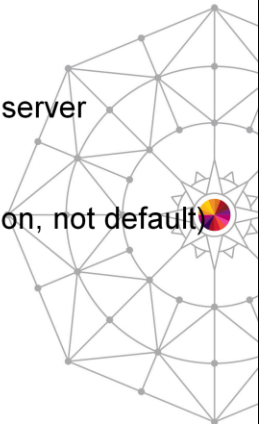



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A minidisk formatted for CMS usage could be considered analogous to a PDS, but you don't need to compress it

CMS Filesystems

- Shared File System (SFS)
 - Filepools under control of Shared File System server
 - Can span physical disks
 - Can create tree-structure (subdirectories)
 - Access control at file level (disk level is an option, not default)
 - Record-Oriented


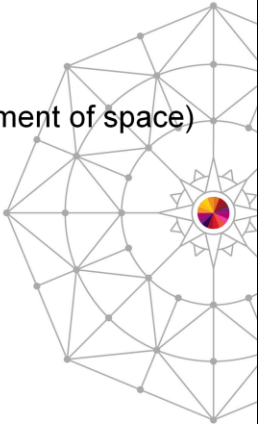



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SFS provides better access control for shared files and more efficient use of disk space, since filepools are shared between authorized users. Users are assigned size limits (quotas in Linux terms) which can be changed on-the-fly by the filepool administrator

CMS Filesystems

- Byte File System (BFS)
 - Similar to SFS (uses SFS servers for management of space)
 - Tree-structured directory
 - Similar to Unix-oriented file systems
 - Byte-oriented



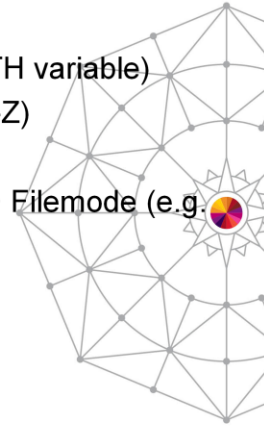
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BFS is used by the z/VM Shell and Utilities, which provides some level of POSIX compliance for z/VM. The z/VM LDAP Server uses BFS

CMS Disk/File Access



- Looking for a Resource:
 - No "Path" statement (no STEPLIB DD or PATH variable)
 - Filesystems are "Accessed" as a filemode (A-Z)
 - Filesystems are scanned in that order (A-Z)
 - Files are referenced by Filename + Filetype + Filemode (e.g. PROFILE EXEC A1)



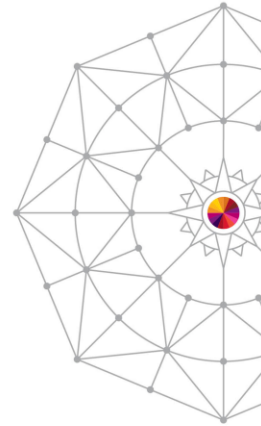
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The first entity to be found during the search will be used; i.e. if you are looking for PROFILE EXEC * and this file exists on the B, D and M disks, the one on the B-disk will be used.

Some Reserved CMS Filetypes

- EXEC – REXX or EXEC2 (shell script)
- HELPxxxx – Help-Related File
- LISTING – Output (Print) File
- MACLIB – Macro Library
- MODULE – Executable Object
- NAMES – CMS Nicknames
- TEXT – Relocateable Object
- TXTLIB – Text Library
- XEDIT – Editor Control File(s)



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Standard CMS Disk/Tape Usage

- 191 Disk or root SFS directory (.)
- 192 Disk
- 190 Disk (System Disk)
- 19E Disk (System Disk Extensions)
- 18x Tape Drive
(e.g. 181 = TAP1, 182=TAP2, etc)

A
D
S
Y/S
TAPx

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The Y/S indication means that the Y-disk is a read-only extension of the S-disk, and that the Y-disk will be searched right after the S-disk (instead of searching T, U, V, W and X disks before searching the Y-disk). The TAPx is the only use of an esoteric in CMS; there is no other concept of an esoteric in CMS.


Command/Shell Processing

- REXX Scripts start with `/* comments */` in line 1 of file
- Little distinction between referencing shell scripts (written in REXX, filetype=EXEC) and executables (filetype=MODULE)
- If CMS doesn't recognize a command, it passes it to CP for execution
 - **Note:** This is not true for other operating systems in a virtual machine




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TSO requires the first line of a REXX proc to say “/* REXX */”. This is unique to TSO REXX and is not required by any other REXX implementation



Common CP/CMS Commands

- HELP – when in doubt, type HELP
- Manage Real Resources for a Virtual Machine (CP)
 - LINK – connect a minidisk to your virtual machine
 - DEFINE – add a virtual device to your virtual machine
 - ATTACH – connect a real device to your virtual machine
 - DETACH – remove a device from your virtual machine
- Manage file availability to a CMS User (CMS)
 - ACCESS – add filesystem to search order
 - RELEASE – remove filesystem from search order
 - VMLINK – general purpose link/access/release/detach exec
- File Maintenance (CMS)
 - FILELIST – view files based on search criteria
 - RDRLIST – view files in virtual card reader
 - XEDIT – native editor of CMS
 - BROWSE – read-only file viewer


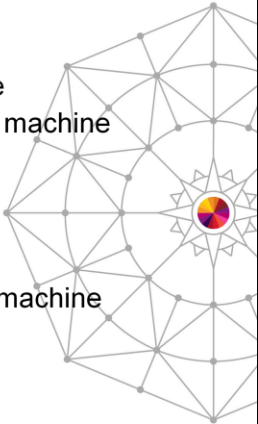



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HELP contains messages and codes, command syntax and “how-to” info, all in one command. Note that some of the listed commands are CP commands, others are CMS commands

Common CP/CMS Commands (cont'd)

- Operating System Operation (CP)
 - LOGON – establish a virtual machine environment
 - IPL – start an operating system in a virtual machine
 - LOGOFF or LOGOUT – destroy the existing virtual machine environment
- Operating Environment Settings (CP/CMS)
 - QUERY – view environmental settings
 - SET – change environmental settings
 - **Note:** Ability to view/set values depends on virtual machine authorizations

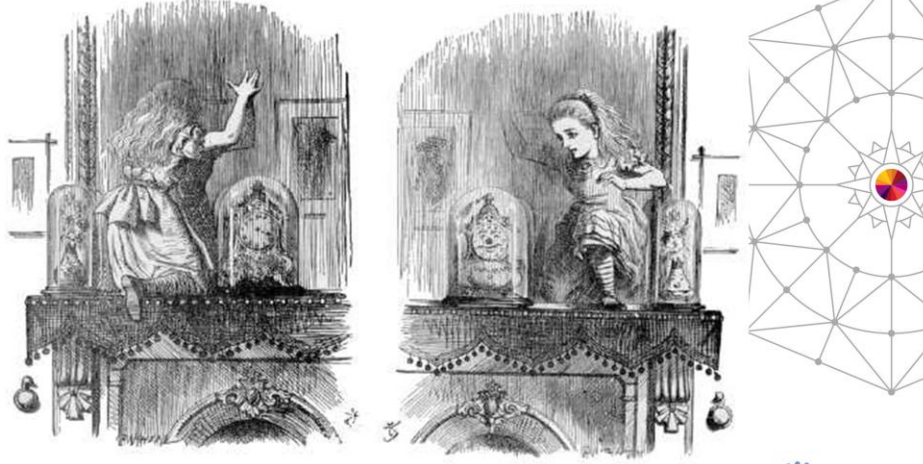


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Remember that if you type LOGOUT or LOGOFF when CP is looking for a command (CP READ in the lower right corner of the console), then the virtual machine goes away. Linux virtual machine console users must be aware of their console mode (RUNNING, VM READ, CP READ, etc) before entering a command or the unexpected may occur.

The challenge for the z/VM SysProg:

Knowing when you are in the Real World
Knowing when you are in the Virtual World



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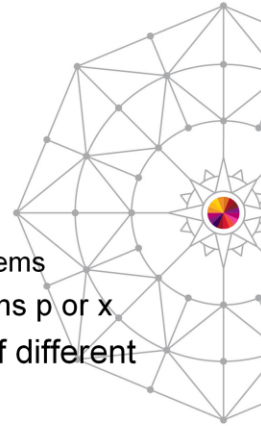
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If you are a z/VM Systems Programmer, you must know which side of the “looking glass” you are on...the real side or the virtual side. You must also know when you are requesting information on the real environment and when you are requesting information on the virtual environment.

Challenges between traditional centralized and distributed computing groups



- Terminology
 - Disk/Memory/Tape vs. “Storage”
 - Disk vs. DASD
- Understanding of Hardware Capability
 - System z CPU design/structure
 - Assist Processors
 - Separate I/O Subsystems and other subsystems
 - Open Systems Adapter vs. NICs on Systems p or x
- Respect for Strengths and Weaknesses of different hardware platforms
 - No system is “perfect”



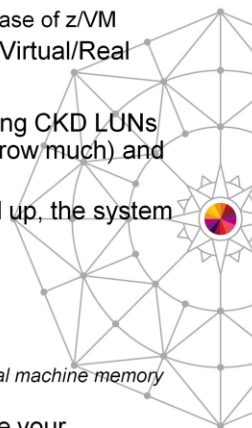
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Linux Considerations under z/VM



- VM Paging Planning
 - See z/VM Planning and Administration Manual for your release of z/VM
 - Depending on workload, can range from 1.2:1 to 2:1 Virtual/Real
- Disk Space/Memory Planning
 - In a mixed CKD/SCSI disk environment, consider using CKD LUNs (3390-3 or 3390-9) for code (which doesn't change/grow much) and SCSI LUNs for data (which tends to grow...a lot)
 - Separate /var from other filesystems so that if logs fill up, the system keeps running
 - Use 2 swap disks
 - First one on a Virtual Disk in Storage (RAM Disk)
 - Allow some swapping to occur to that one
 - Second one on a z/VM minidisk
 - Swapping to this one means that you need to tune your virtual machine memory allocation
 - Don't throw memory at a Linux virtual machine....tune your application, then tune your memory



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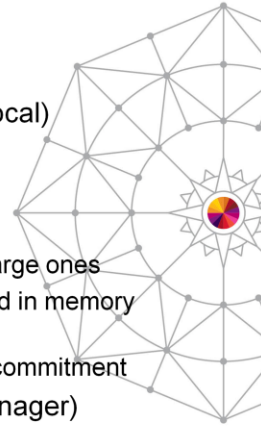


z/VM Paging changed a lot between 6.3 and earlier releases. Use of Expanded Storage was normal prior to z/VM 6.3. Virtual-to-real planning is very dependent on the type of application you are running....database servers need to have all their 'defined' (to the database) memory available, while application servers may be ok to allow some overcommitment of memory.

Linux Considerations under z/VM (cont'd)



- Don't use rules-of-thumb from other platforms
- Don't install everything available in a distribution
- Separate filesystems (see previous page)
 - Isolate filesystems that may grow (/home, /usr/local)
 - Don't let root filesystem (/) fill up
 - /var, /tmp sizes vary wildly
- Plan for ongoing tuning of the environment
 - Smaller memory footprints may perform better than large ones
 - Databases should be tuned to what they actually need in memory
 - Little to no memory over-commitment possible
 - Application servers are candidates for memory over-commitment
- Plan for filesystem growth (use Logical Volume Manager)
- Plan for managing code changes
 - Shared r/o minidisks may simplify this

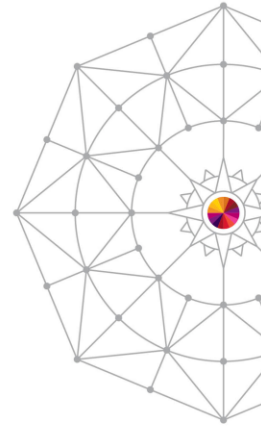


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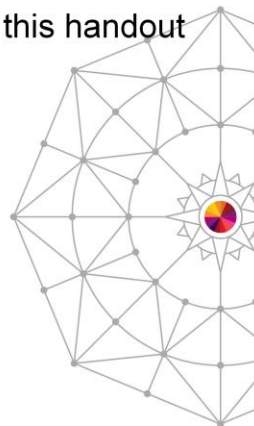
- SHARE sessions this week
- IBM Enterprise Technical University (usually 4Q)
- IBM z/VM Collection Kit (SK2T-2067)
 - Orderable at <http://www.ibm.com/publications>
- IBM z/VM Web site
 - <http://www.vm.ibm.com>
- IBM RedBooks
 - <http://www.redbooks.ibm.com>
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Survey


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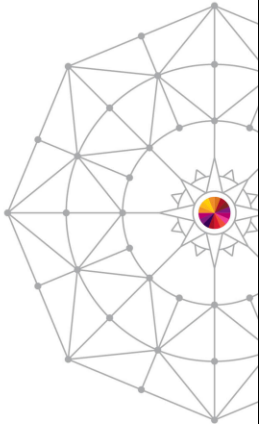



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More Details





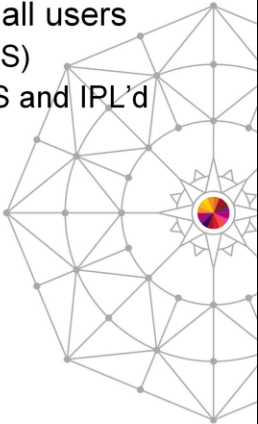


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Technology • Commerce • People

CP Topics - Shared Segments


- Commonly-used code can be shared among all users
 - Termed Discontiguous Shared Segment (DCSS)
 - Operating Systems can be loaded into a DCSS and IPL'd using a Named Saved System (NSS)
 - CMS is an example of an NSS
- Similar in concept to Shared LPA (z/OS)



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in Anaheim

A Linux kernel can be made into an NSS, saving up to 1.5MB of private virtual storage per guest, although . This should be considered when you have many Linux instances.


Technology • Connections • Results

CP Topics – DASD Usage

- Allocation Byte Map
 - Cylinder 0, Head 0
 - 1 byte/cylinder (through 3390-27, different mapping for larger disks)
 - Used by CP-Owned Devices
 - Indicates usage of disk space (PERM, DRCT, PAGE, SPOOL, TDISK, PARM)
 - Starting with z/VM Version 5, full-pack PAGE and SPOOL packs bypass the Allocation Byte Map area
 - You'll see allocation (PAGE or SPOOL) starting in cylinder 0



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If you are planning to use full volumes for z/VM page/spool space, you must understand the role of the allocation byte map or strange and apparently random bad things may happen to your running system

CP Topics – System Startup

- IPL (Initial Program Load)
 - Specified device address on HMC/SE
 - Stand-Alone Loader started if console address is entered in LOADPARM
 - Looks in PARM area for CP Nucleus (module) and System Configuration File
 - Console is required **only** during CP IPL sequence
 - Can use HMC “Operating System Messages” (device SYSC) or “Integrated 3270 Console” (device SYSG)
 - These devices are already defined in the IBM-delivered product



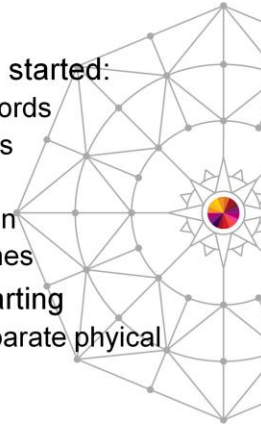
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The Allocation Byte Map is read by CP for all CP-OWNED volumes as listed in the System Configuration file. CP Dump Space is allocated in Spool based on the amount of real storage that CP sees at IPL time

CP Topics –System Startup (cont'd)



- IPL (cont'd)
 - Following CP IPL, five virtual machines are started:
 - EREP – gathers hardware/software error records
 - DISKACNT – gathers disk accounting records
 - OPERSYMP – gathers symptom records
 - OPERATOR – system interface or automation
 - AUTOLOG1 – autostarts other virtual machines
 - You can disable any or all of these from starting
 - z/VM does not require an “Operator” or a separate physical console device



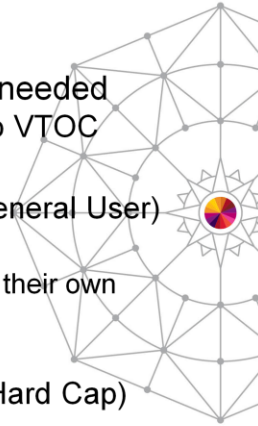
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You must plan for log management of EREP and DISKACNT space; most shops use the VMUTIL virtual machine for this via the WAKEUP service (similar to CRON)

CP Topics – Other Items

- Dynamic I/O
 - Can add any real device on-the-fly
- Unlike z/OS, No I/O Definition File (IODF) needed
 - CP-managed disks (with minidisks) have no VTOC
- Command Classes
 - A-G Pre-defined (A = Highest Level, G = General User)
 - Can define your own classes
 - Consider putting FORCE and XAUTOLOG in their own class for Help Desk personnel
- Performance Tuning
 - SET SHARE (Relative/Absolute, Soft Cap/Hard Cap)



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IODF is an option starting with z/VM 4.4; it is **not** required