



## Session B32

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### z/VM's Control Program (CP) Part 1 - Useful Things to Know

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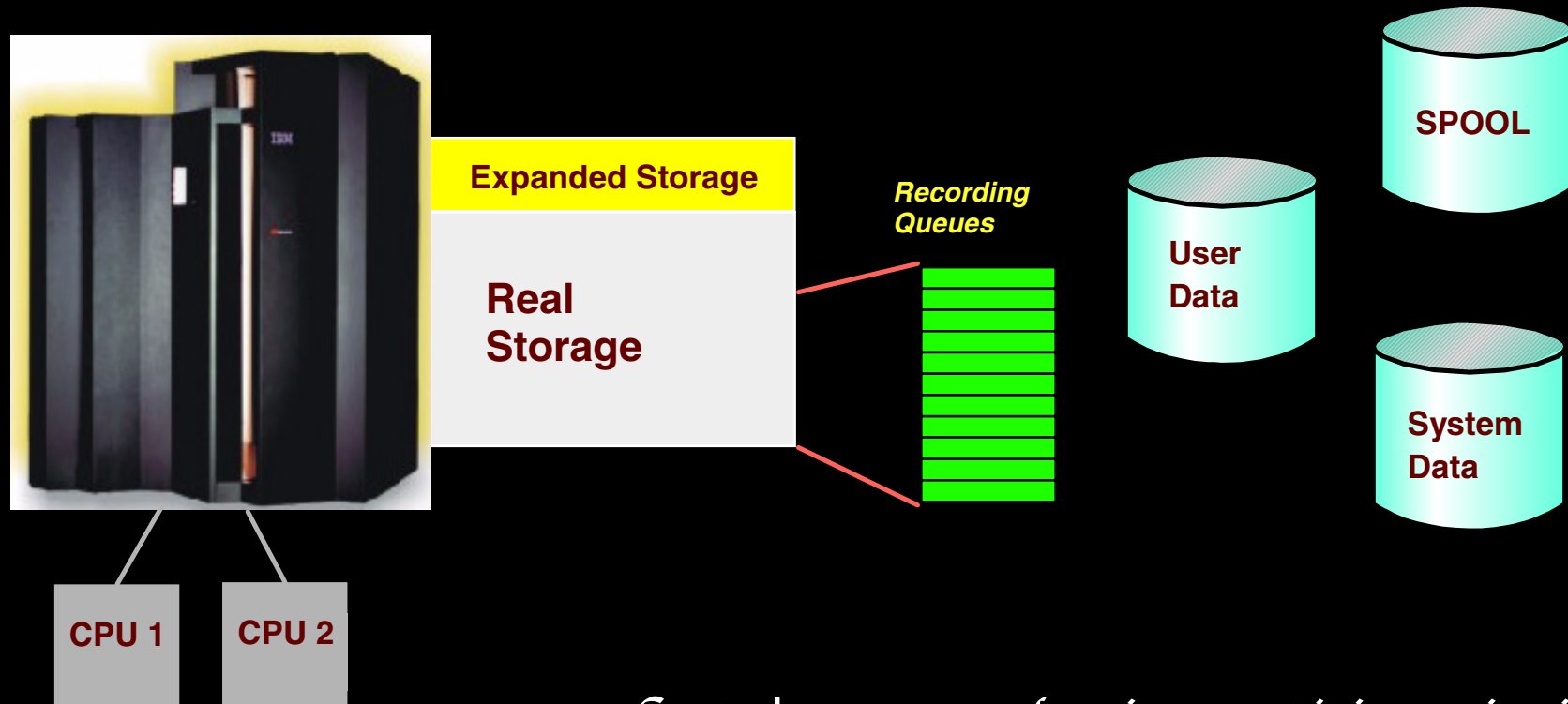
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# Topics

- *Overview of z/VM's CP Facilities and Functions*
- *Starting (IPLing) CP*
  - What you need
  - Saving and Restoring information
- *Defining and Creating Virtual Machines*
- *Virtual Machine Connectivity and Networking*
  - Virtual Machine Communication
  - Virtual Networking
- *Interacting with CP*

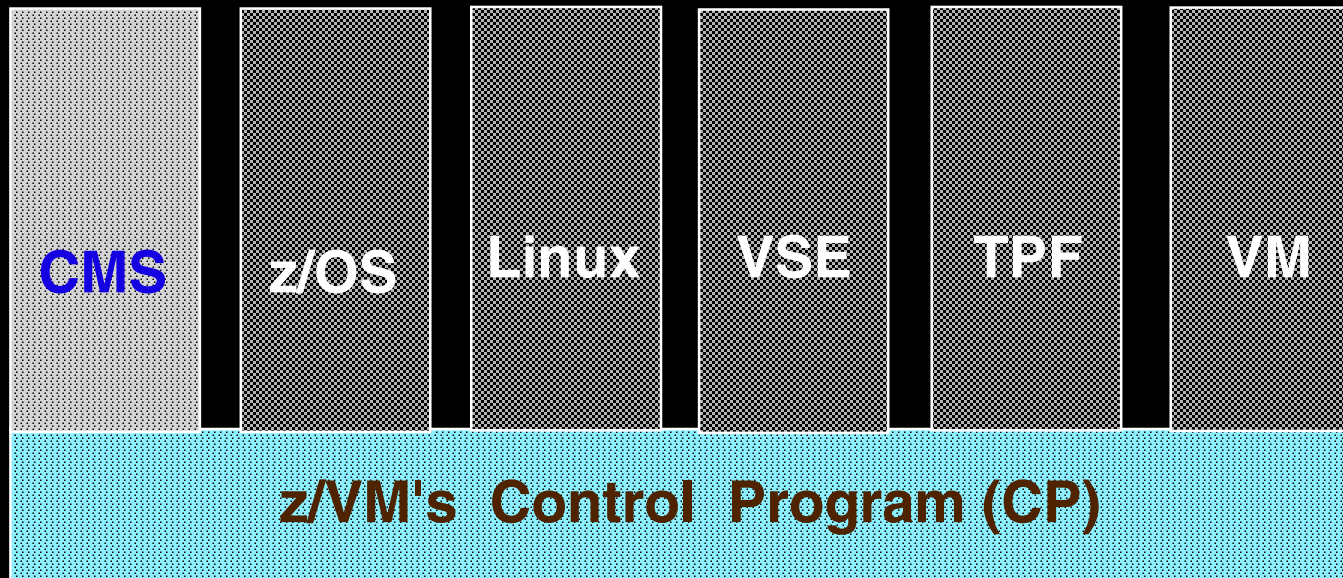
# *Overview of CP*

# CP - z/VM's System Control Program



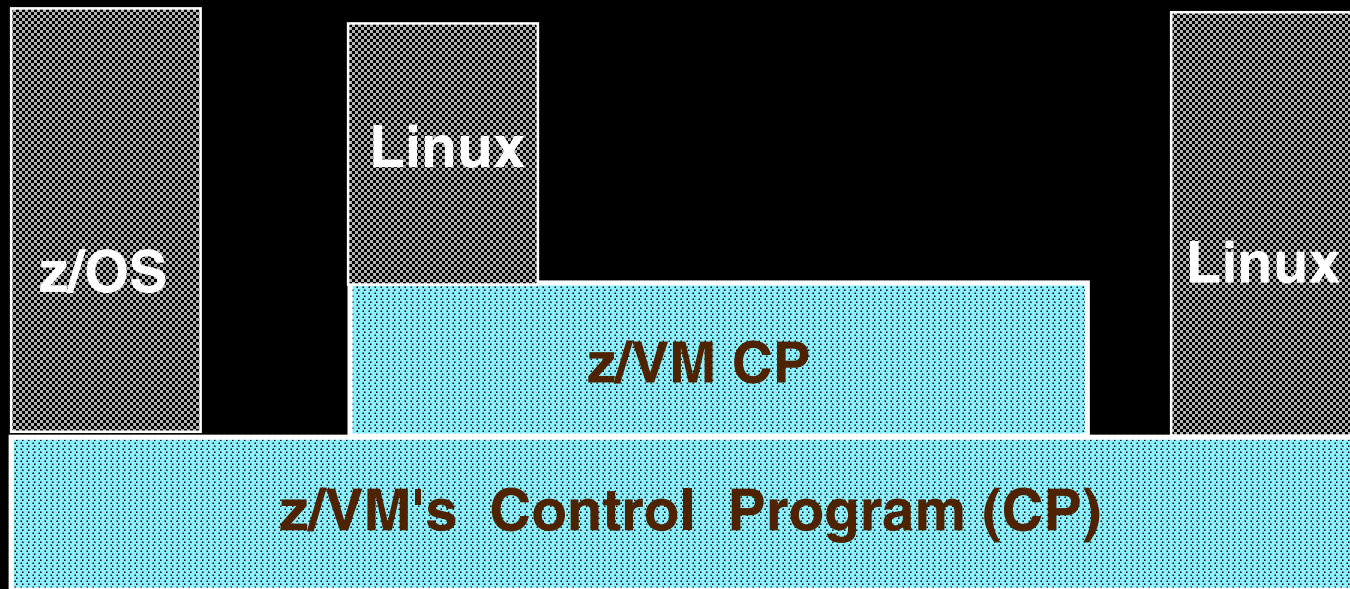
- ▶ Controls resources of environment it is running in
  - *Native*
  - *LPAR*
  - *Virtual machine*
- ▶ Manages storage (memory) and devices
- ▶ Records usage and system event data
- ▶ Provides error recovery facilities

## *CP - z/VM's System Control Program...*



- ***Manages virtual machines***
  - ▶ ESA/390 and z/Architecture
  - ▶ Guest operating systems
  - ▶ Interactive users
    - *CMS is a special single user operating system that is part of z/VM*
- ***Shares real resources among virtual machines***
- ***Supports connectivity among virtual machines***
  - ▶ Virtual networking
  - ▶ Data sharing and exchanging information

## *CP - z/VM's System Control Program...*



### *Supports multiple layers of virtualization*

- ▶ z/VM can run as a guest in a virtual machine
- ▶ Guest z/VM system may host its own guest operating systems



# CP Device Support

## *Real Devices (RDEVs)*

- Sensed by CP at IPL time
  - ▶ *Can also be defined to CP in system config file or dynamically*
- Attached or dedicated to a single virtual machine for its exclusive use
- Virtualized and shared among several virtual machines
- Used by CP for system functions

## *Virtual Devices (VDEVs)*

- Appear to virtual machine as a real device
- Defined
  - ▶ *In virtual machine's directory*
  - ▶ *Dynamically after virtual machine is active*
- Either virtualized or simulated
  - ▶ *Virtualized - presents an image of a real device to virtual machines*
  - ▶ *Simulated - defined to virtual machine without an associated real device*

# *CP Disk Space ("CP Owned")*

## *CP "owns" disk space for system functions*

- **PERM**
  - ▶ *Checkpoint and Warmstart areas*
  - ▶ *User minidisks (do not have to be CP Owned)*
  - ▶ *Could contain CP Module*
- **PARM**
  - ▶ *CMS Minidisk containing system configuration files*
  - ▶ *Usually contains CP Module*
- **DRCT**
  - ▶ *User directory (created with DIRECTXA Utility)*
- **PAGE**
  - ▶ *System paging*
- **SPOL**
  - ▶ *Spool files, including DUMP files and System Data files*
- **TDSK**
  - ▶ *Temporary disk space available to users*

## *CP Disk Space ("CP Owned")...*

- *CP disk space is defined in CP\_Owned configuration file statement*

```
CP_Owned Slot 1 JF IRES
CP_Owned Slot 2 SPOOL0
CP_Owned Slot 3 MDSP0
CP_Owned Slot 4 RESERVED
```

- ▶ *May be added dynamically to a running system*

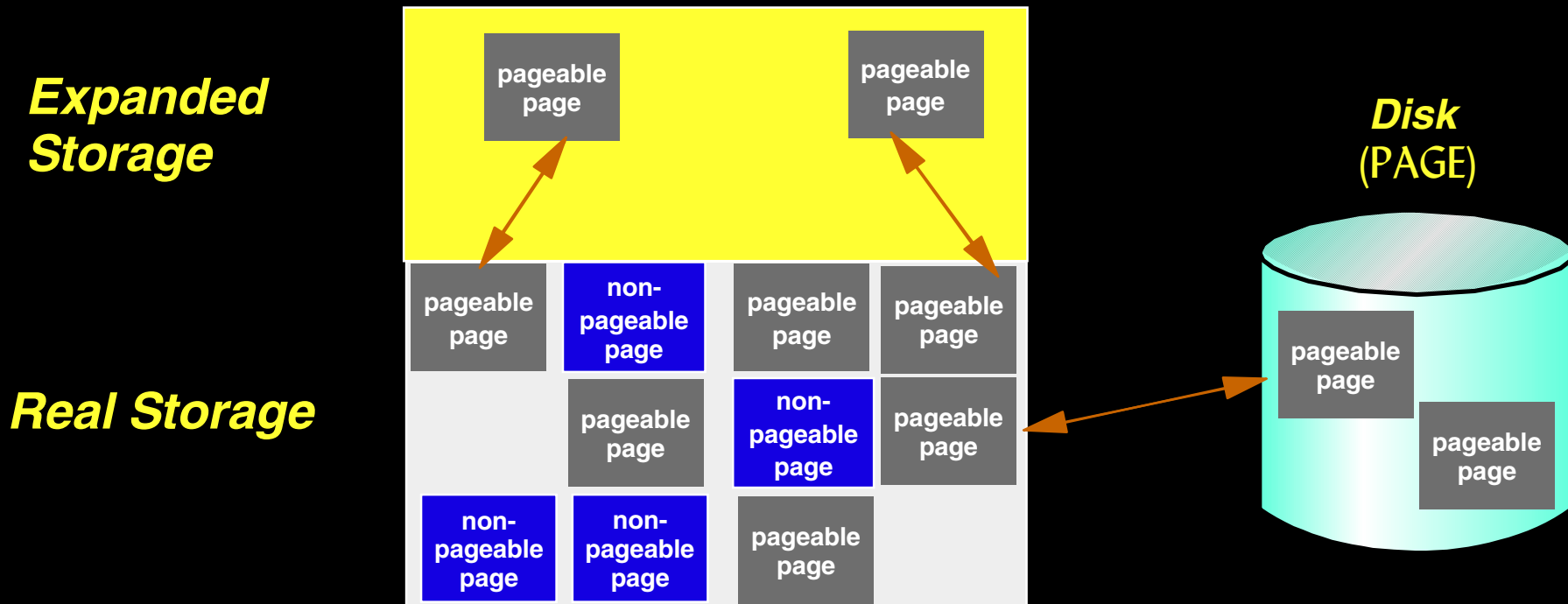
- *CPFMTXA Utility formats and allocates types of CP disk space*
- *QUERY CPOWNED command shows list of CP owned disk volumes*

*query cpowned*

```
Slot Vol-ID Rdev Type Status
  1 JF IRES 0A40 Own Online and attached
  2 SPOOL0 0780 Own Online and attached
  3 MDSP0 0880 Own Online and attached
  4 ----- ---- ----- Reserved
```

- *QUERY ALLOC command shows various views of CP disk usage*

# Managing Real Storage Among Virtual Machines



## CP optimizes use of real storage for virtual machines

- ▶ Virtual machine storage is pageable
  - ➔ *Demand paged* - only paged out when necessary
- ▶ Paged to
  - ➔ *Expanded storage*
  - ➔ *Disk (CP-Owned PAGE area)*

# CP SPOOLing

## *Simulates real unit record devices*

- Virtual unit record devices defined for each virtual machine
  - ▶ *Reader*
  - ▶ *Printer*
  - ▶ *Punch*
- Reads input (reader) files and makes data available
- Writes data into output (punch or printer) files
- Files may be sent to (or read from) associated real devices

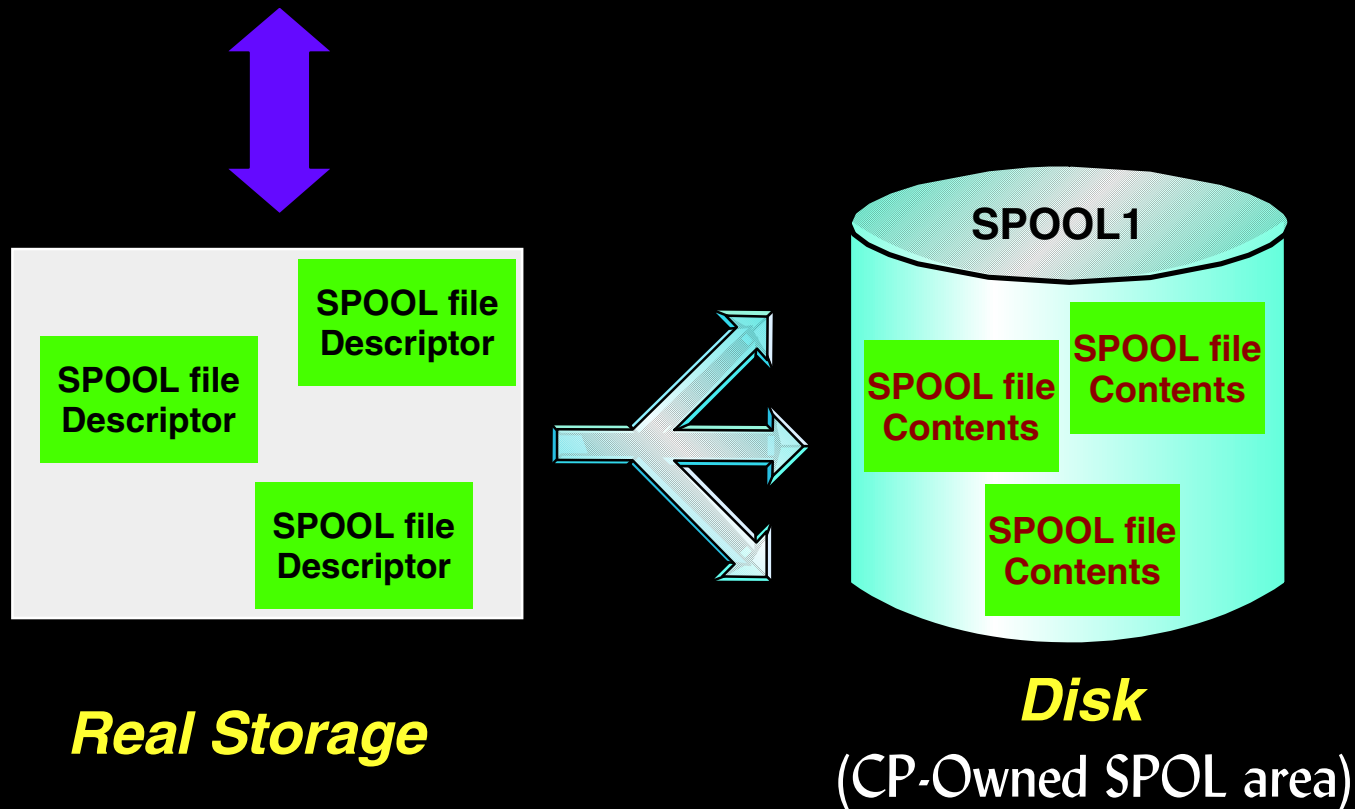
## *SPOOL files are used for*

- E-mail
- Transferring information between virtual machines and systems
- Sending (or receiving) information from associated real devices
- Saving console output
- System and virtual machine dumps
- Specific system functions

# CP SPOOLing...

```
q rdr all
```

ORIGINID	FILE	CLASS	RECORDS	CPY	HOLD	DATE	TIME	NAME	TYPE	DIST
OPERATOR	0039	A PUN	00000089	001	NONE	09/02	15:50:06	PROFILE	EXEC	35H:0253
OPERATOR	0037	A RDR	00000006	001	NONE	08/29	15:08:52			OPERATOR
U1	0043	A PUN	00000045	001	NONE	08/03	15:05:53	PROFILE	EXEC	U1



# *CP SPOOLing - System Data Files*

## *Special SPOOL files used by CP for system functions*

- NSS (Named Saved System)
  - ▶ *Named copy of an operating system*
- DCSS (DisContiguous Saved Segment)
  - ▶ *Shared copy of data and/or code*
- IMG (Image Library)
  - ▶ *Definitions such as spacing and character sets used by printers*
- UCR (User Class Restructure)
  - ▶ *Customized privilege class information for commands and diagnose codes*
- NLS (National Language Support)
  - ▶ *Message repositories for translated z/VM messages*
- TRF (System Trace Files)
  - ▶ *System Trace data generated by a virtual machine*
  - ▶ *Created by TRSOURCE and TRSAVE commands*

# *Named Saved Systems and Saved Segments*

## *NSS (Named Saved System)*

- Code is saved in a segment
- Can be IPL'd by name (e.g. CMS)
  - ▶ *Single copy on system for N virtual machines instead of N copies*

## *DCSS (DisContiguous Saved Segment)*

- Used to contain shared
  - ▶ *Data*
  - ▶ *Code*
- Single copy is shared among all virtual machines

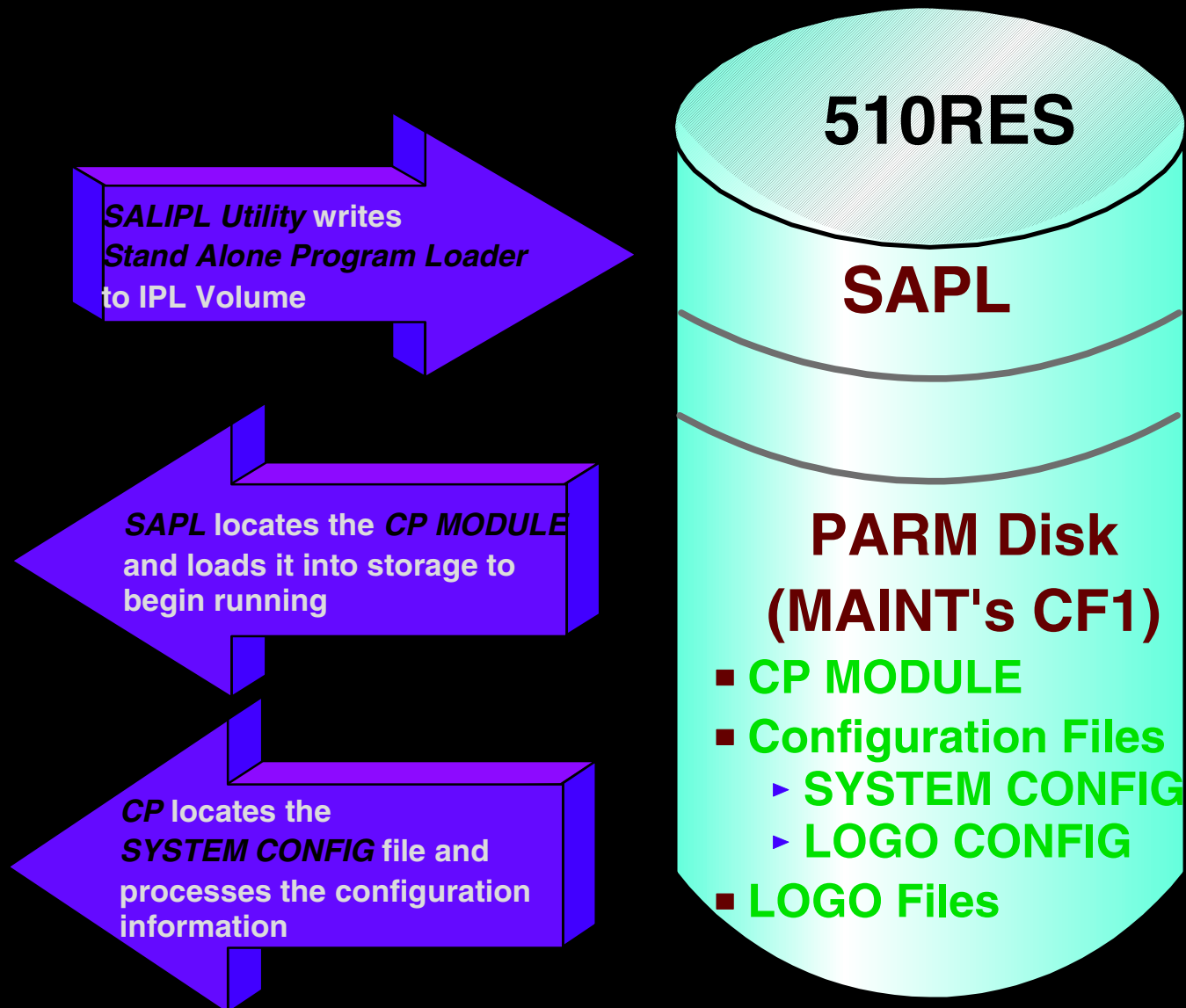
## *Created with DEFSYS and DEFSEG commands*

- Skeleton files
- Must be saved with SAVESYS and SAVESEG commands before they can be used by virtual machines



*Starting (IPLing) CP*

# What you Need to IPL CP



## *Restoring Information during IPL*

*CP saves system environment and data during SHUTDOWN, including:*

- Accounting, EREP, and Symptom records
- Unit record device status
- System log message
- Spool files
- System data files

*Type of IPL determines how much saved system information is restored*

- WARM
  - ▶ *Restores all information saved during SHUTDOWN*
- FORCE
  - ▶ *Restores as much saved information as possible*
- COLD
  - ▶ *Only restores system data files*
- CLEAN
  - ▶ *Does not restore any saved information*

## Restoring System Data - Checkpoint Area

### System data to be restored during an IPL (WARM or FORCE)

- ▶ Located on a CP -owned volume
- ▶ Not necessarily the IPL volume

System\_Residence ,  
Checkpoint Valid 510RES From Cylinder 3 For 9 ,  
Warmstart Valid 510RES From Cylinder 12 For 1

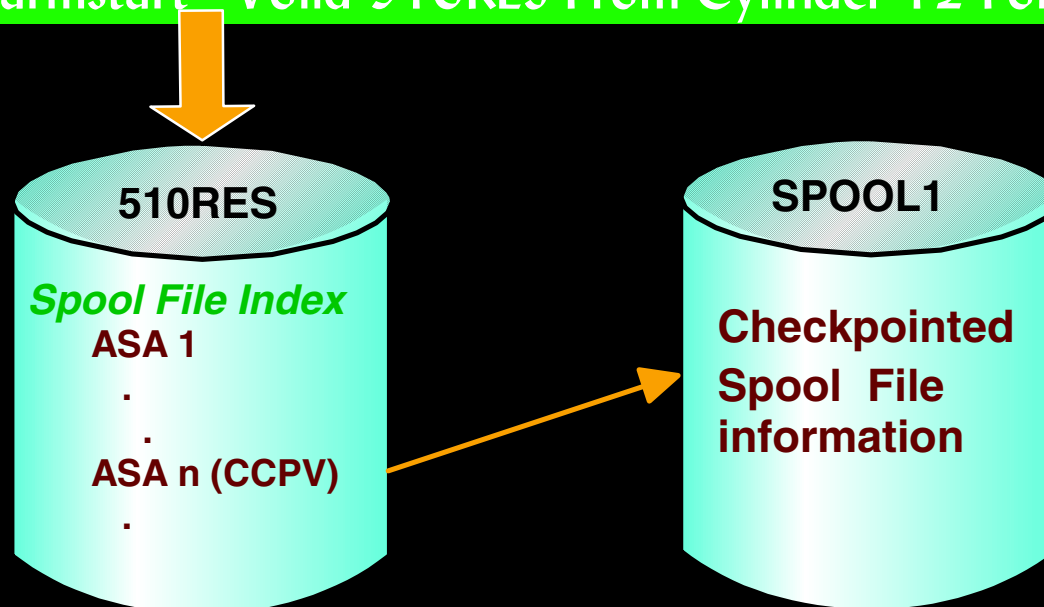


# Restoring System Data... Warmstart Area

## Spool Files to be restored during a system restart

- ▶ One entry per file : 4-byte Disk (Auxiliary Storage) Address
- ▶ Updated whenever a spool file is created or deleted

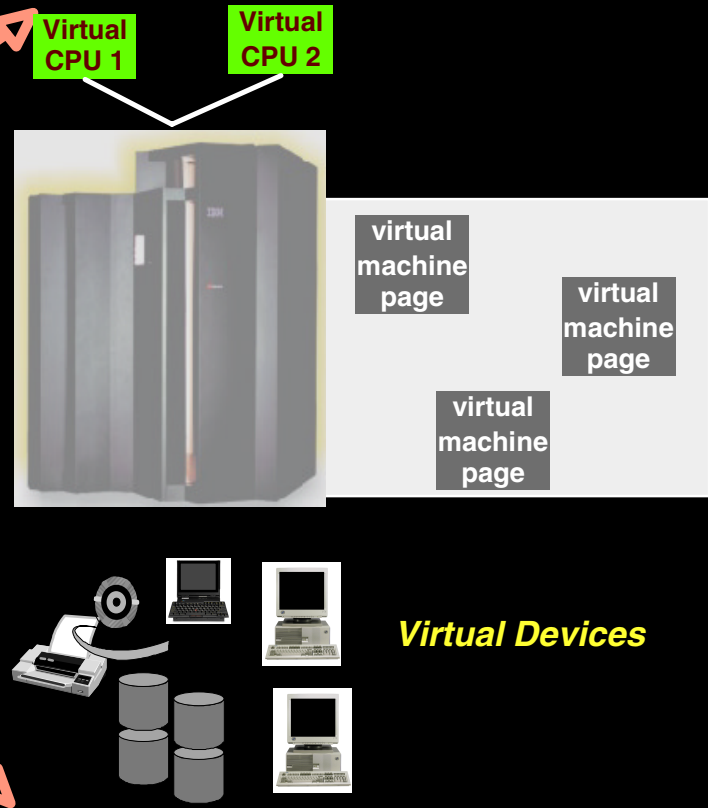
System\_Residence ,  
Checkpoint Valid 510RES From Cylinder 3 For 9 ,  
Warmstart Valid 510RES From Cylinder 12 For 1



# *Virtual Machines*

# Defining a Virtual Machine

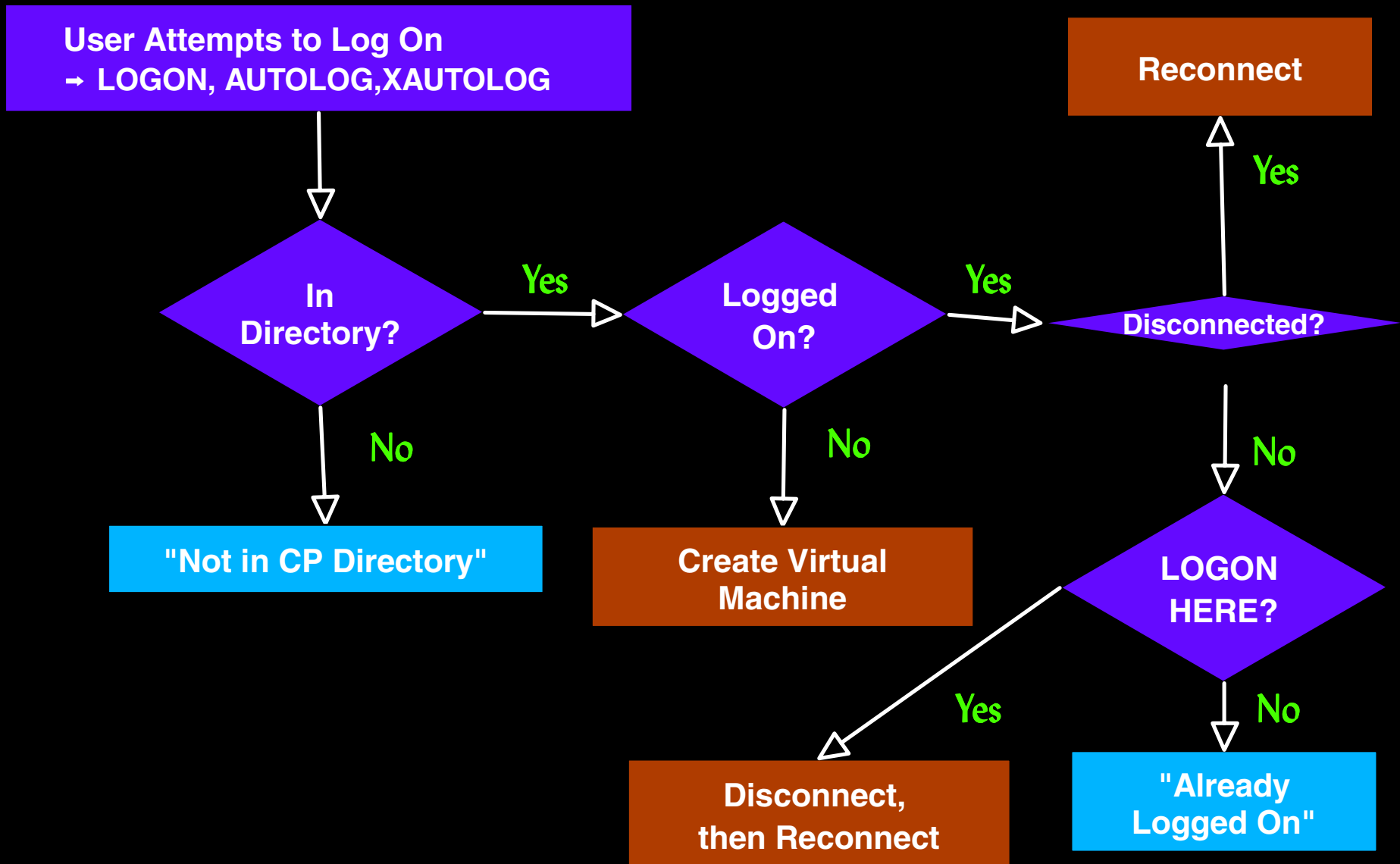
```
USER U1      U1PW 32M 32G G
IPL 190  PARM AUTOCR
MACHINE ESA 2
CONSOLE 009 3215 T MAINT
SPOOL 00C 2540 READER A
SPOOL 00D 2540 PUNCH A
SPOOL 00E 1403 A
MDISK 191 3390 000 009 JAF191 MR
MDISK 193 3390 000 017 JAF193 RR
LINK MAINT 190 190 RR
LINK MAINT 19E 19E RR
```



*Created when a user logs on*

- ▶ Real hardware and features are virtualized
  - Processors
  - Devices
  - Storage
- ▶ Aggregate of virtual objects and storage may be greater than available real resources

# Logging on to z/VM (creating a virtual machine)





*Virtual Machine  
Connectivity  
and  
Networking*

# *Communication between Virtual Machines*

## *IUCV (Inter-User Communication Vehicle)*

- provides an efficient data transfer protocol unique to the VM platform

## *Virtual CTCA*

- simulates existence of real Channel-to-Channel devices for each Virtual Machine

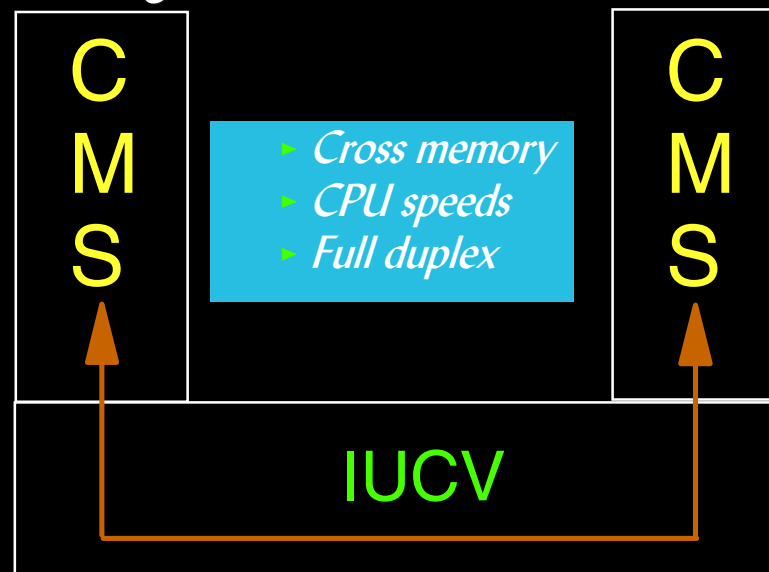
## *Virtual NIC*

- simulates existence of real Network Interface Cards for each Virtual Machine

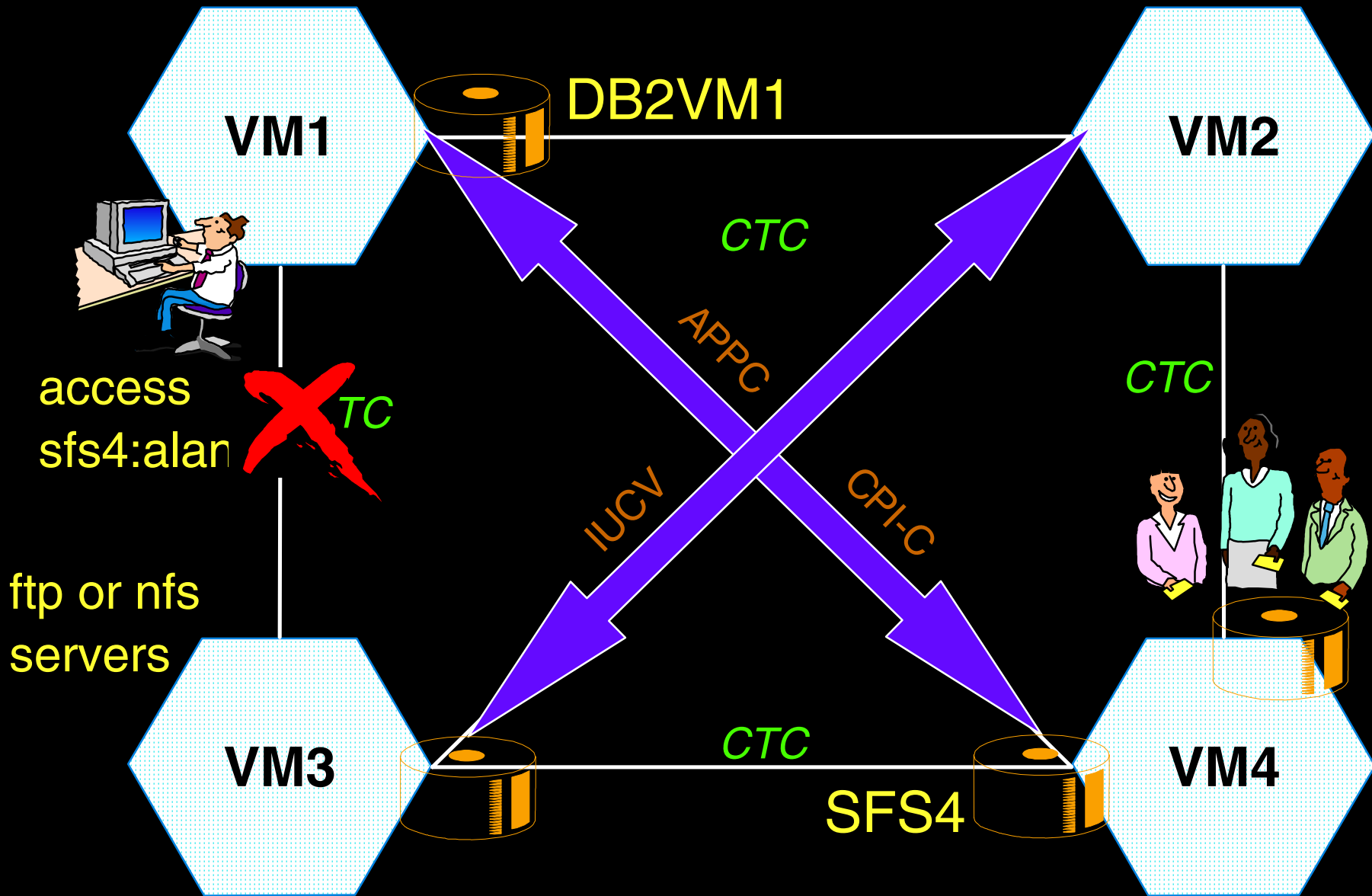
# IUCV Communication

## Inter-User Communication Vehicle (IUCV)

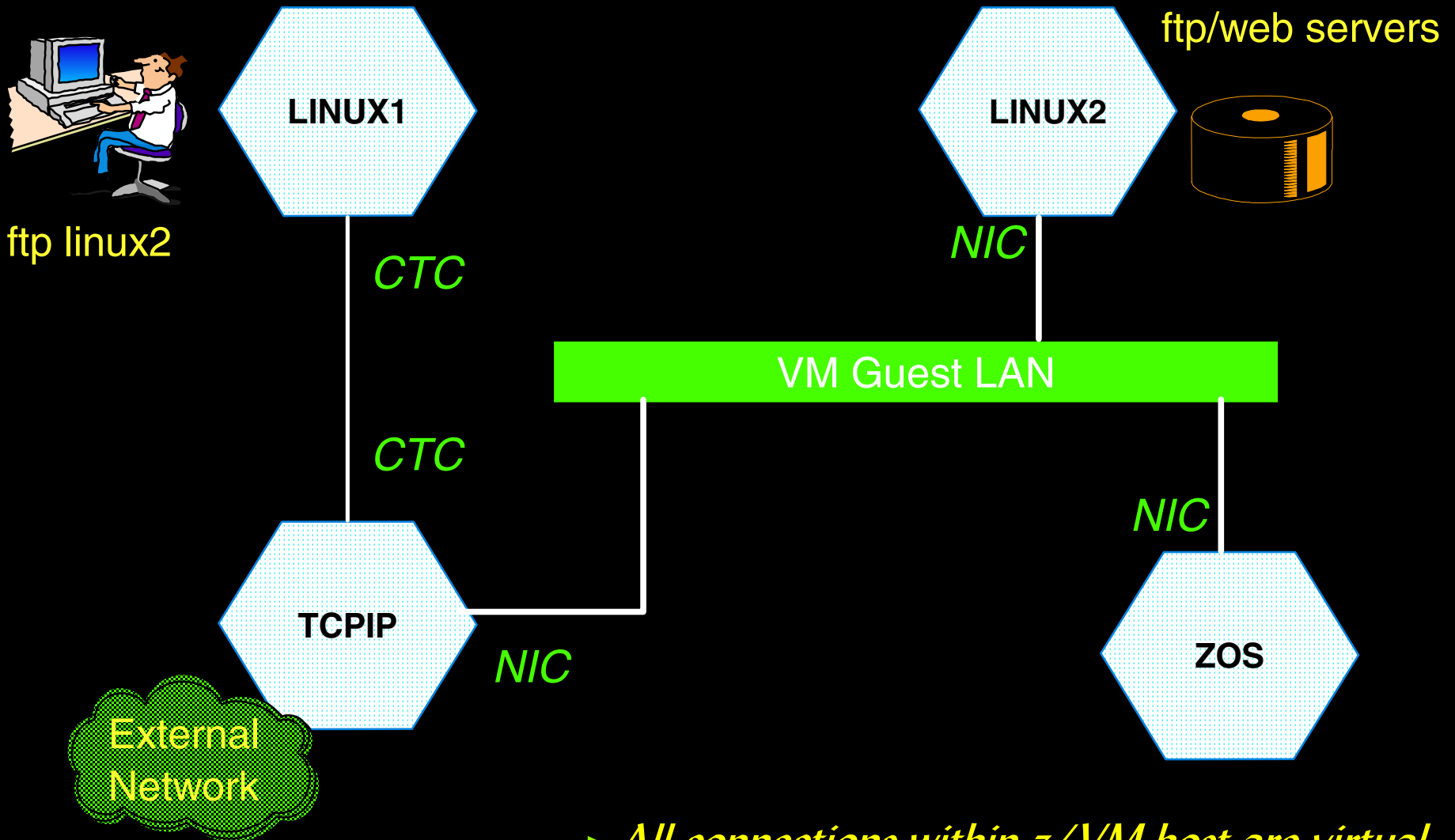
- Allows communication between an application and other virtual machines or CP system services
- Simultaneous communication over multiple connections allowed for each virtual machine
- Transparent communication between virtual machines on different systems via ISFC (*Inter-System Facility for Communications*)
- Point-to-Point networking between Linux and z/VM TCP/IP



# A VM Collection

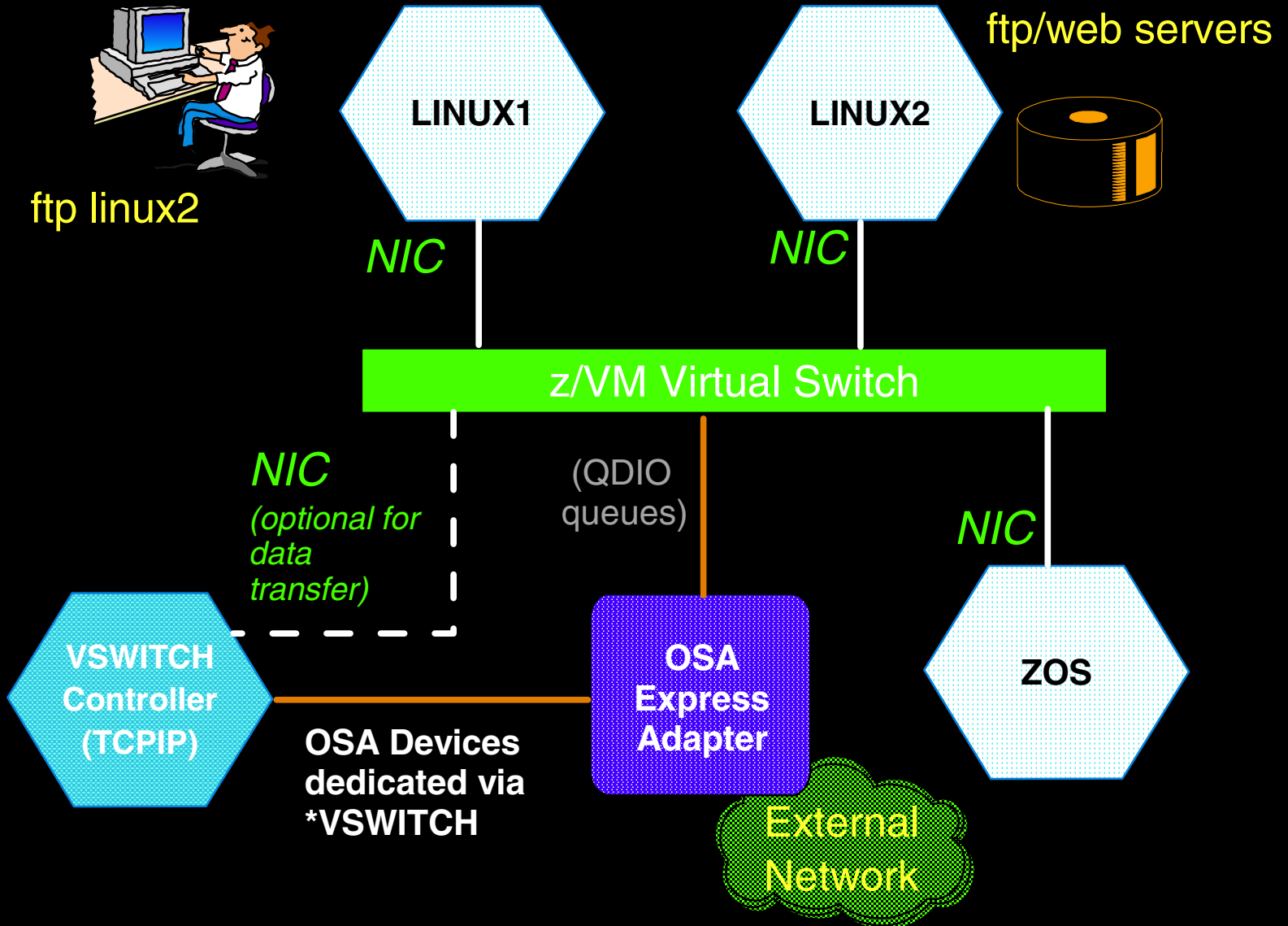


# A Virtual Network (Guest LAN)



- ▶ *All connections within z/VM host are virtual*
  - no physical connections are necessary

# A Virtual Network (z/VM Virtual Switch)



*Interacting with CP*

# CP Commands

*Used for a variety of purposes, including:*

- System Operator functions
- System status
- DEFINE/SET/QUERY
  - ▶ *system and virtual machine characteristics*
  - ▶ *real/virtual device settings*
  - ▶ *system and user data*
- Assigning/releasing system resources
- Moving data and files between users
- Communicating between virtual machines





# Privilege Classes

*Determine which CP commands a user (virtual machine) may issue*

- Privilege classes may be modified
  - ▶ *User*
  - ▶ *Command*

<b>Class</b>	<b>Type of User and Function</b>
A	<b>System Operator:</b> responsible for availability of system and resources
B	<b>System Resource Operator:</b> controls real resources of system, except for those controlled by the system operator and spooling operator
C	<b>System Programmer:</b> Changes system-wide parameters
D	<b>Spooling Operator:</b> Controls spool files and system's real reader, printer, and punch equipment
E	<b>System Analyst:</b> Examines and saves system operation data
F	<b>Service Representative:</b> Reserved for IBM use
G	<b>General User:</b> Controls functions associated with a particular virtual machine
Any	Commands available to any user regardless of the user's privilege class

# *CP Programming Interfaces*

*Provide application programs with access to*

- CP Services
- Data created by CP to be processed by applications
- Certain CP data areas

*Types of programming interfaces*

- Diagnose Codes
- CP System Services
- IUCV and APPC/VM macros
- Address space macros (ESA/XC virtual machines)



# Customizing CP

## CP Exit support

- Allows non-disruptive additions and deletions of customized CP routines
  - ▶ *CP Commands*
  - ▶ *Diagnose Codes*
  - ▶ *Message Repositories*
  - ▶ *Exit Routines (user modifications to CP)*
- No need to shutdown and IPL to apply user code
  - ▶ *Modifications applied with commands and configuration file statements*
- Minimizes rework to user code due to IBM source code changes

# *Summary*

# Summary

## *VM's Control Program (CP):*

- Efficiently manages the environment it is running in
  - ▶ *Native*
  - ▶ *LPAR*
  - ▶ *Virtual Machine*
- Preserves and restores data across system IPLs
- Manages processors, memory, and devices among virtual machines
- Virtualizes resources for use by virtual machines
  - ▶ *Guest Operating Systems*
  - ▶ *End Users*
- Provides virtual networking and connectivity
- Provides command and programming interfaces

*See the VM Library for more details*  
<http://www.vm.ibm.com/library/>