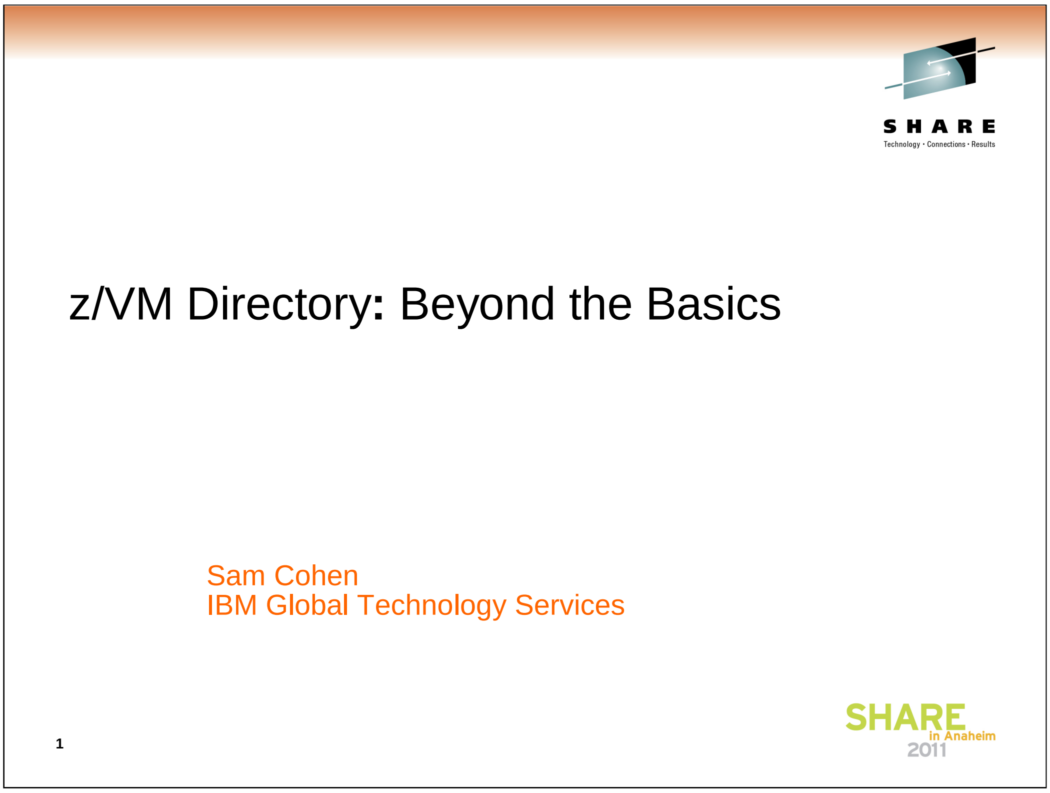

z/VM Directory: Beyond the Basics

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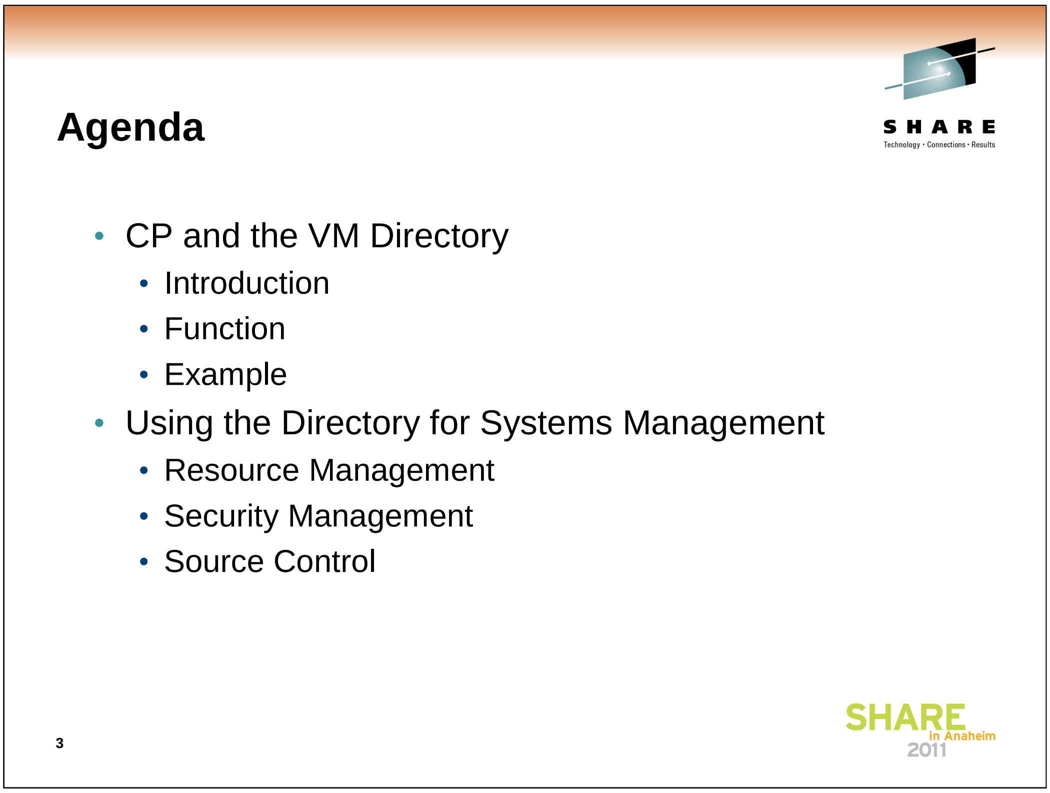

Agenda

- CP and the VM Directory
  - Introduction
  - Function
  - Example
- Using the Directory for Systems Management
  - Resource Management
  - Security Management
  - Source Control

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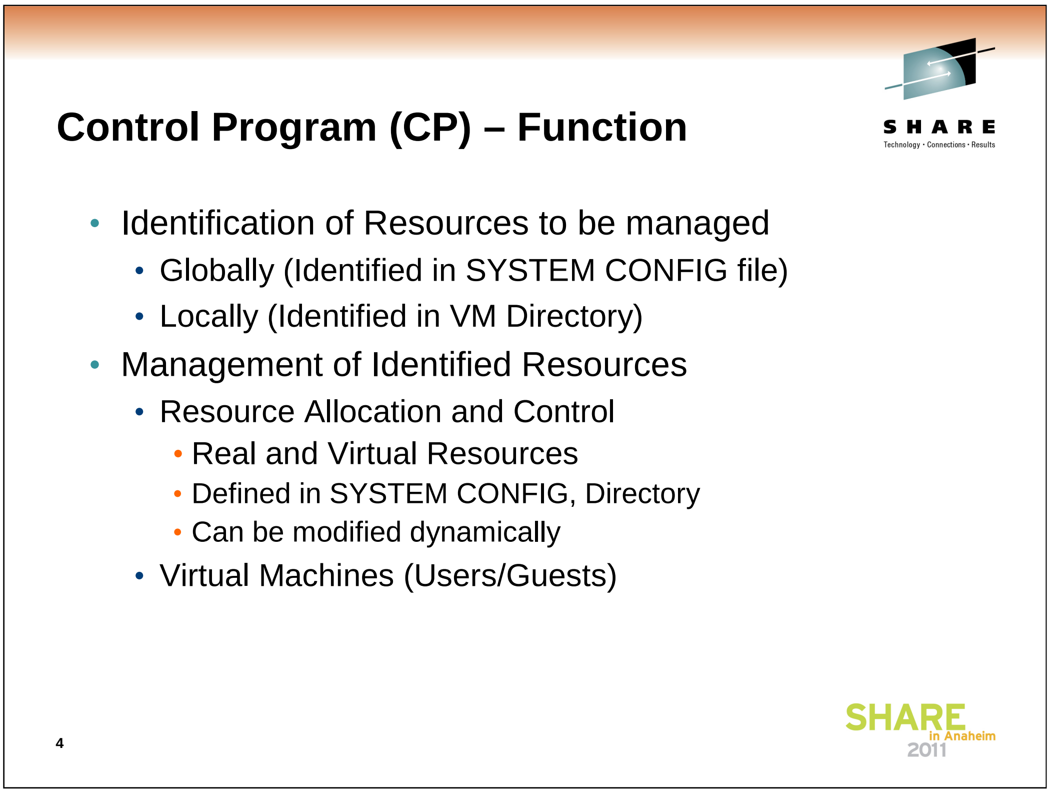
This talk is focused on the role of the VM directory, especially how it can help with Systems Management

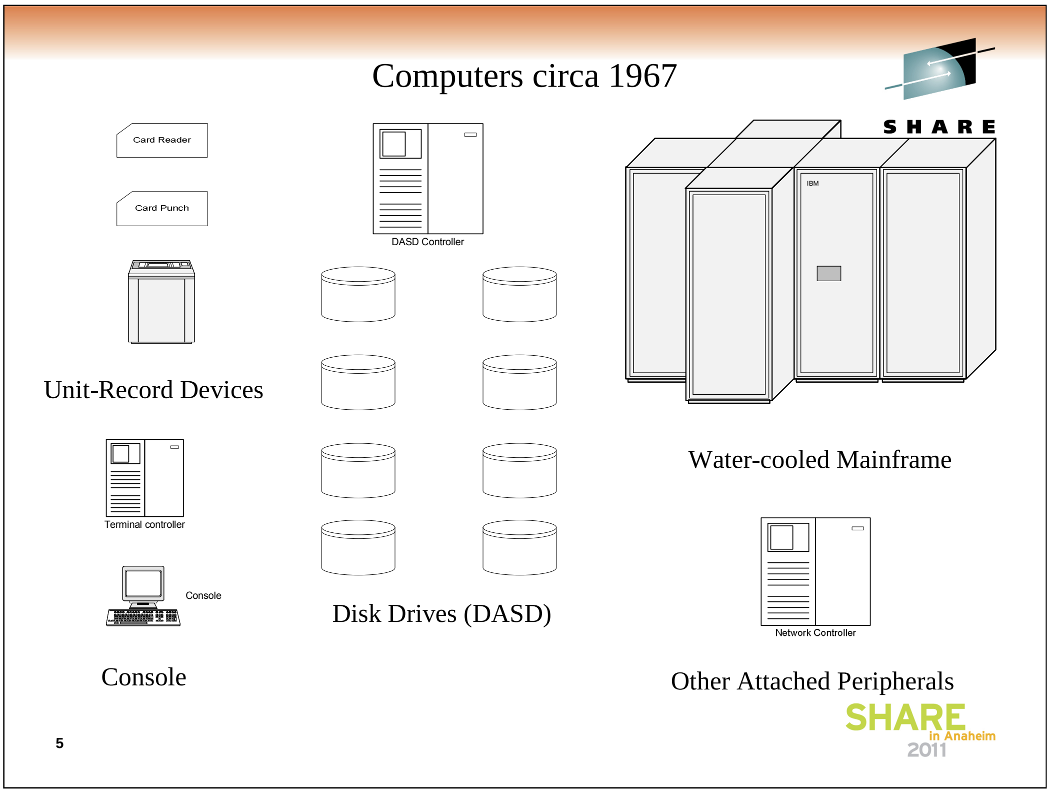


Control Program (CP) – Function

- Identification of Resources to be managed
  - Globally (Identified in SYSTEM CONFIG file)
  - Locally (Identified in VM Directory)
- Management of Identified Resources
  - Resource Allocation and Control
    - Real and Virtual Resources
    - Defined in SYSTEM CONFIG, Directory
    - Can be modified dynamically
  - Virtual Machines (Users/Guests)

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.



Computers circa 1967

Unit-Record Devices

Console

Disk Drives (DASD)

Water-cooled Mainframe

Other Attached Peripherals

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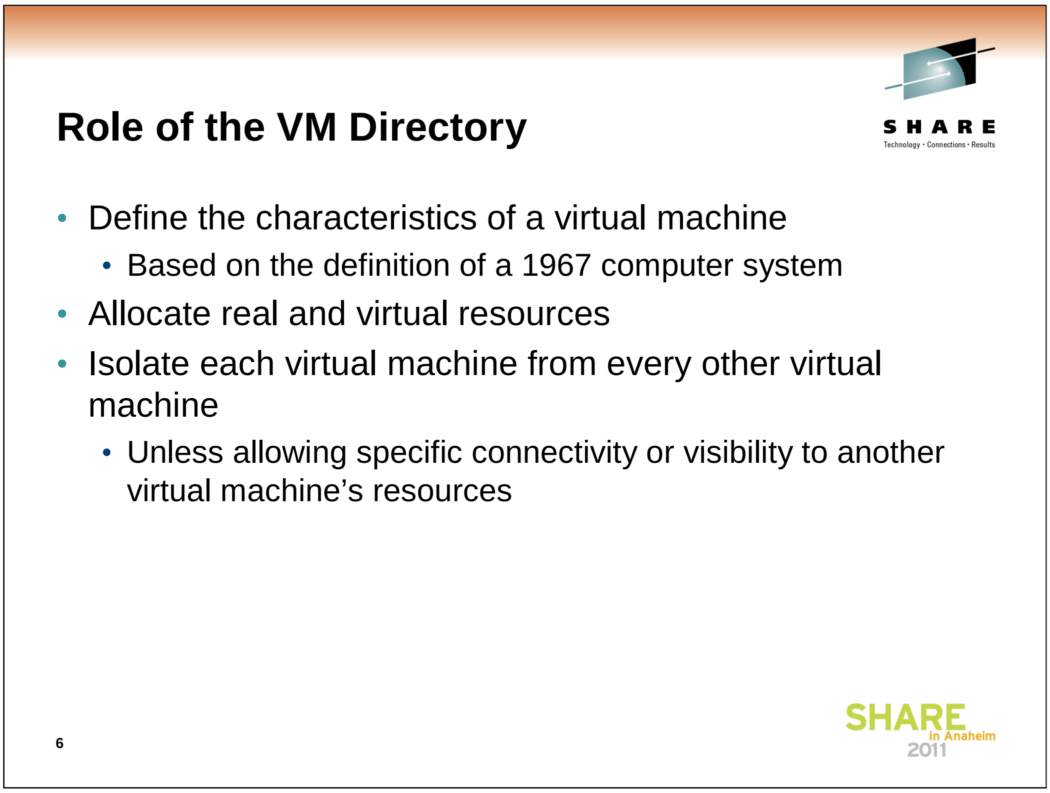
So, what made up a computer in 1967? A computer had:

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



Role of the VM Directory

- Define the characteristics of a virtual machine
  - Based on the definition of a 1967 computer system
- Allocate real and virtual resources
- Isolate each virtual machine from every other virtual machine
  - Unless allowing specific connectivity or visibility to another virtual machine's resources

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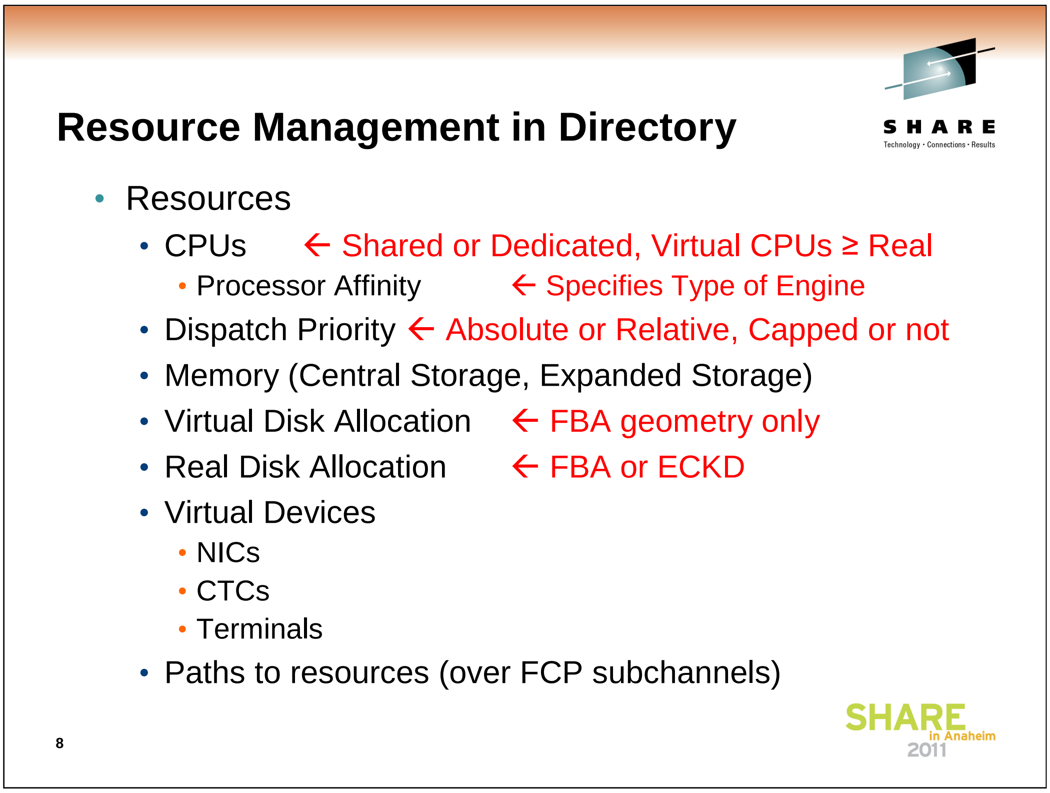
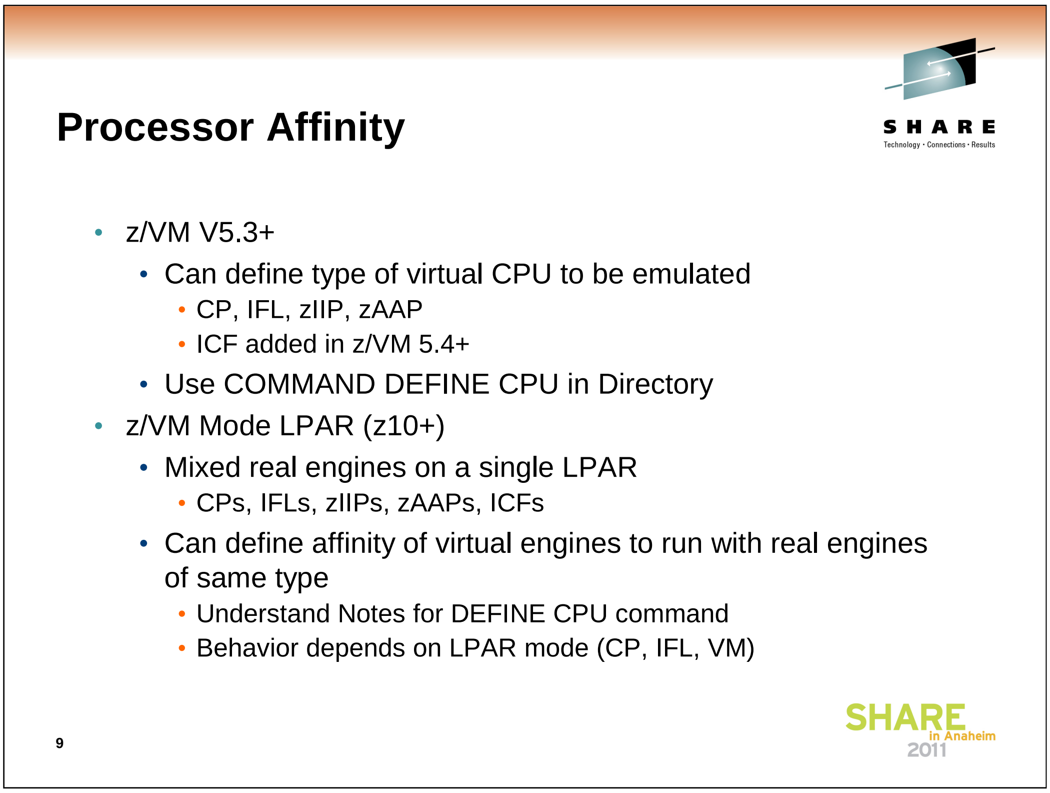
Resource Management in Directory



Resource Management in Directory

- Resources
  - CPUs ← Shared or Dedicated, Virtual CPUs ≥ Real
    - Processor Affinity ← Specifies Type of Engine
  - Dispatch Priority ← Absolute or Relative, Capped or not
  - Memory (Central Storage, Expanded Storage)
  - Virtual Disk Allocation ← FBA geometry only
  - Real Disk Allocation ← FBA or ECKD
  - Virtual Devices
    - NICs
    - CTCs
    - Terminals
  - Paths to resources (over FCP subchannels)

CPUs can be shared or dedicated. You can allocate more virtual processors than actually exist (This would be a case where you are not dedicating CPUs, since there is not a 1:1 relationship.)



Processor Affinity

- z/VM V5.3+
  - Can define type of virtual CPU to be emulated
    - CP, IFL, zIIP, zAAP
    - ICF added in z/VM 5.4+
  - Use COMMAND DEFINE CPU in Directory
- z/VM Mode LPAR (z10+)
  - Mixed real engines on a single LPAR
    - CPs, IFLs, zIIPs, zAAPs, ICFs
  - Can define affinity of virtual engines to run with real engines of same type
    - Understand Notes for DEFINE CPU command
    - Behavior depends on LPAR mode (CP, IFL, VM)

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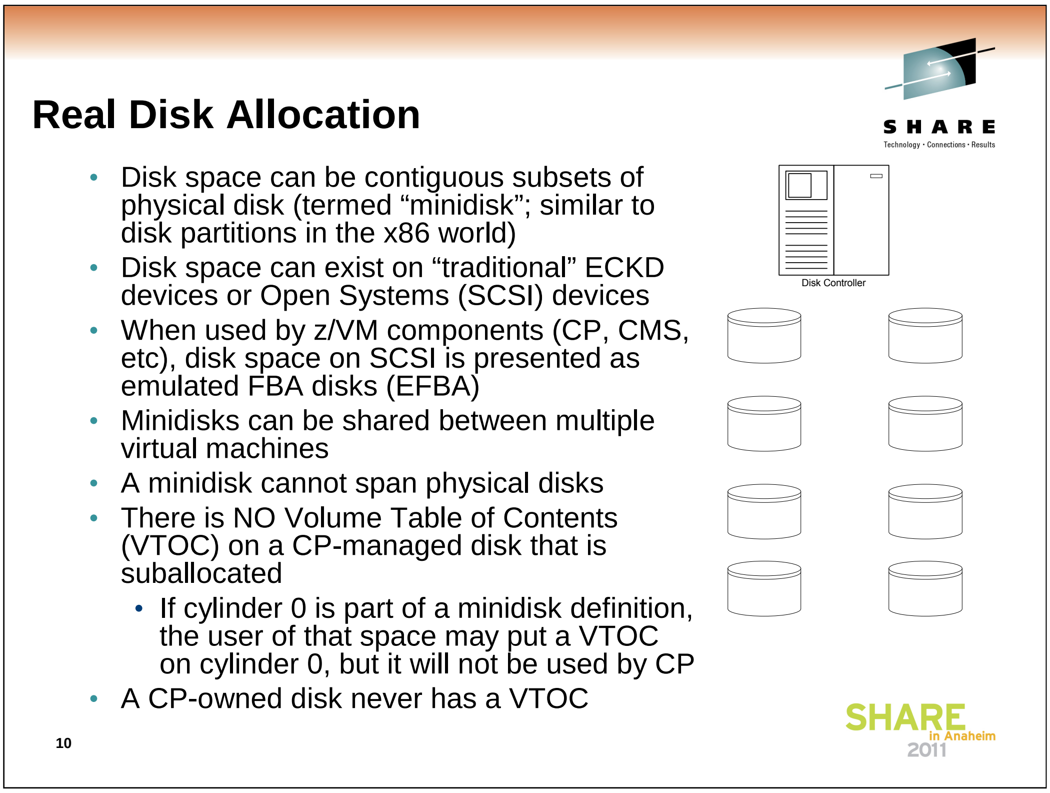
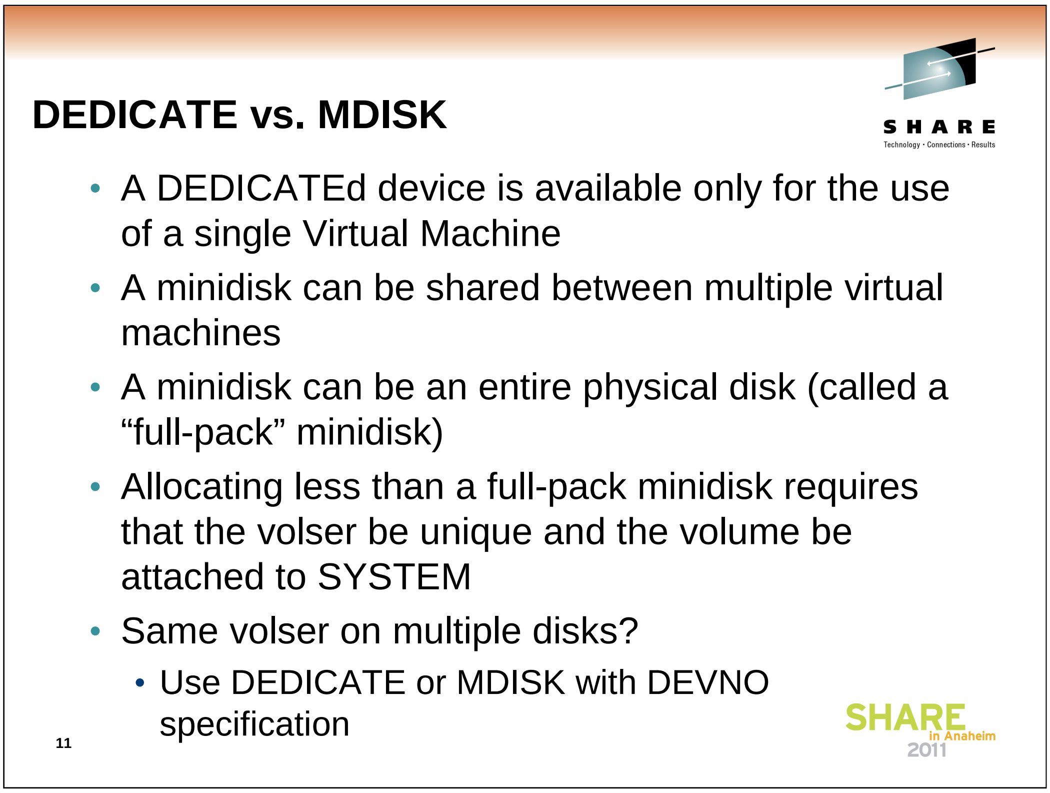
Hardware systems prior to the z10 did not allow you to mix CPs and IFLs in the same LPAR. z/VM mode LPARs allow mixed real engine types to be in a single LPAR. This may allow you to reduce the number of LPARs.

You can issue the DEFINE CPU command within a virtual machine, but placing it in the directory allows the virtual machine environment to be defined prior to the IPL of an operating system.



Real Disk Allocation

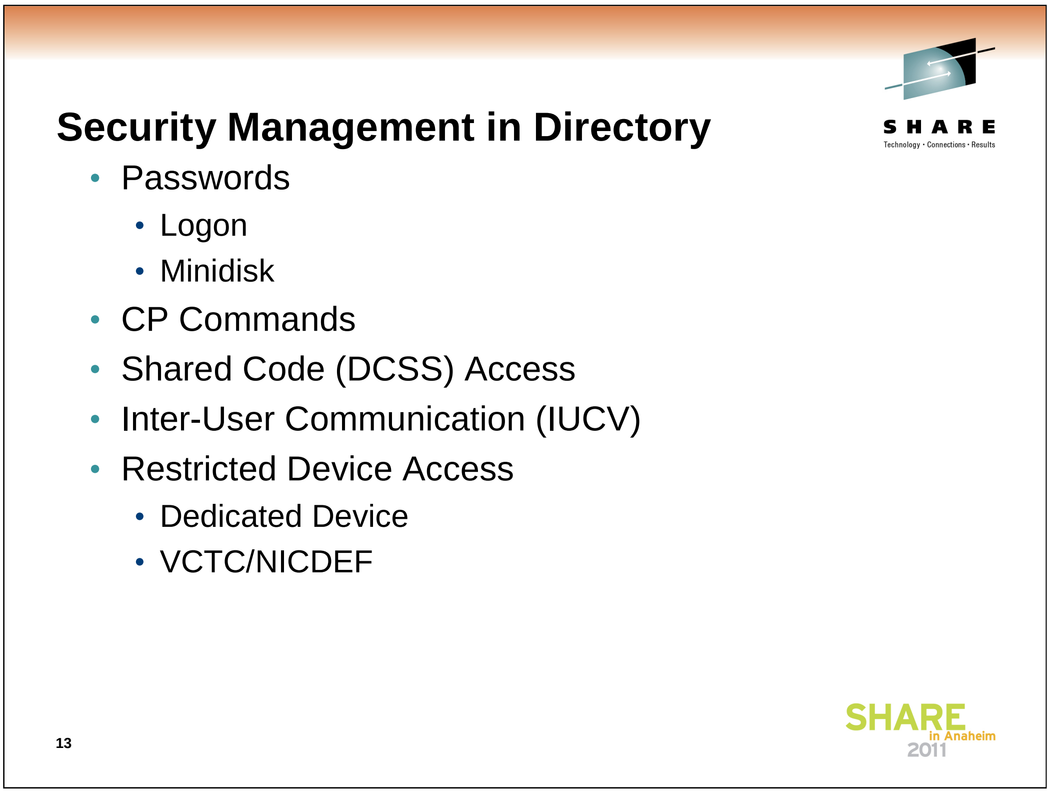
- Disk space can be contiguous subsets of physical disk (termed “minidisk”; similar to disk partitions in the x86 world)
- Disk space can exist on “traditional” ECKD devices or Open Systems (SCSI) devices
- When used by z/VM components (CP, CMS, etc), disk space on SCSI is presented as emulated FBA disks (EFBA)
- Minidisks can be shared between multiple virtual machines
- A minidisk cannot span physical disks
- There is NO Volume Table of Contents (VTOC) on a CP-managed disk that is suballocated
  - If cylinder 0 is part of a minidisk definition, the user of that space may put a VTOC on cylinder 0, but it will not be used by CP
- A CP-owned disk never has a VTOC



DEDICATE vs. MDISK

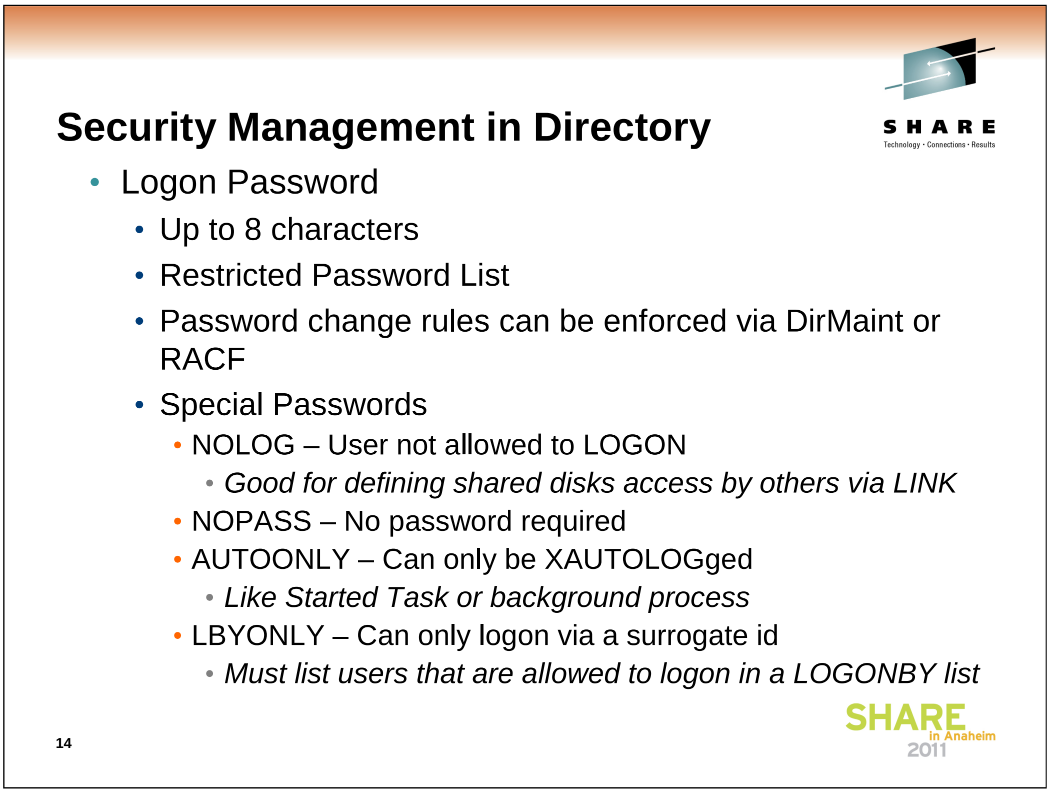
- A DEDICATEd device is available only for the use of a single Virtual Machine
- A minidisk can be shared between multiple virtual machines
- A minidisk can be an entire physical disk (called a “full-pack” minidisk)
- Allocating less than a full-pack minidisk requires that the volser be unique and the volume be attached to SYSTEM
- Same volser on multiple disks?
  - Use DEDICATE or MDISK with DEVNO specification

Security Management in Directory



Security Management in Directory

- Passwords
  - Logon
  - Minidisk
- CP Commands
- Shared Code (DCSS) Access
- Inter-User Communication (IUCV)
- Restricted Device Access
  - Dedicated Device
  - VCTC/NICDEF



Security Management in Directory

- Logon Password
  - Up to 8 characters
  - Restricted Password List
  - Password change rules can be enforced via DirMaint or RACF
  - Special Passwords
    - NOLOG – User not allowed to LOGON
      - *Good for defining shared disks access by others via LINK*
    - NOPASS – No password required
    - AUTOONLY – Can only be XAUTOLOGged
      - *Like Started Task or background process*
    - LBYONLY – Can only logon via a surrogate id
      - *Must list users that are allowed to logon in a LOGONBY list*

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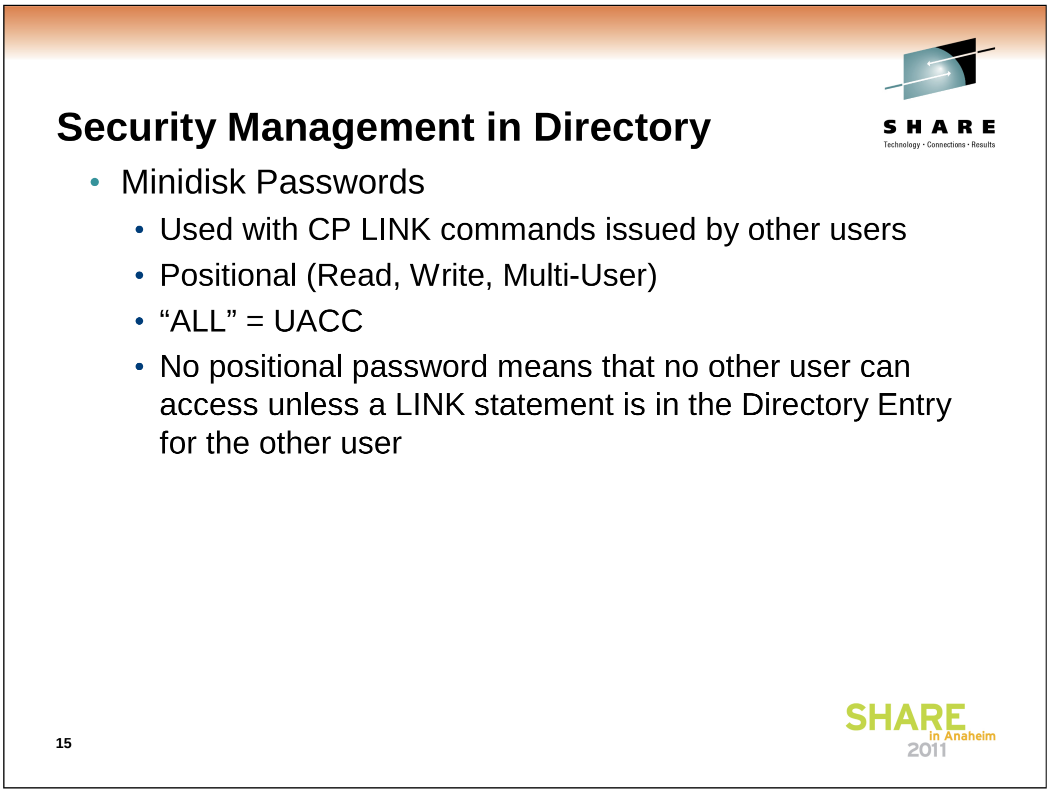
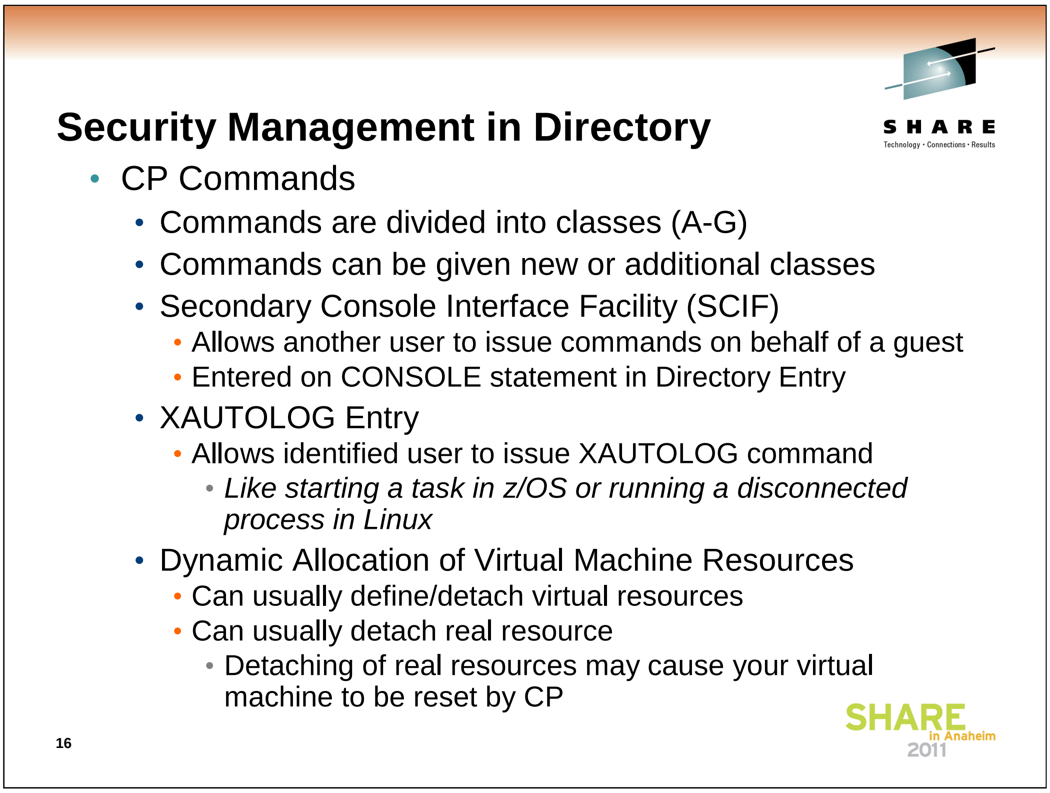
Logon Passwords are in clear text in the Directory Source. If this presents a security concern, you may need to install and use RACF and DirMaint to hide and encrypt logon passwords (they work together).



Security Management in Directory

- Minidisk Passwords
  - Used with CP LINK commands issued by other users
  - Positional (Read, Write, Multi-User)
  - “ALL” = UACC
  - No positional password means that no other user can access unless a LINK statement is in the Directory Entry for the other user



Security Management in Directory

- CP Commands
  - Commands are divided into classes (A-G)
  - Commands can be given new or additional classes
  - Secondary Console Interface Facility (SCIF)
    - Allows another user to issue commands on behalf of a guest
    - Entered on CONSOLE statement in Directory Entry
  - XAUTOLOG Entry
    - Allows identified user to issue XAUTOLOG command
      - *Like starting a task in z/OS or running a disconnected process in Linux*
  - Dynamic Allocation of Virtual Machine Resources
    - Can usually define/detach virtual resources
    - Can usually detach real resource
      - Detaching of real resources may cause your virtual machine to be reset by CP

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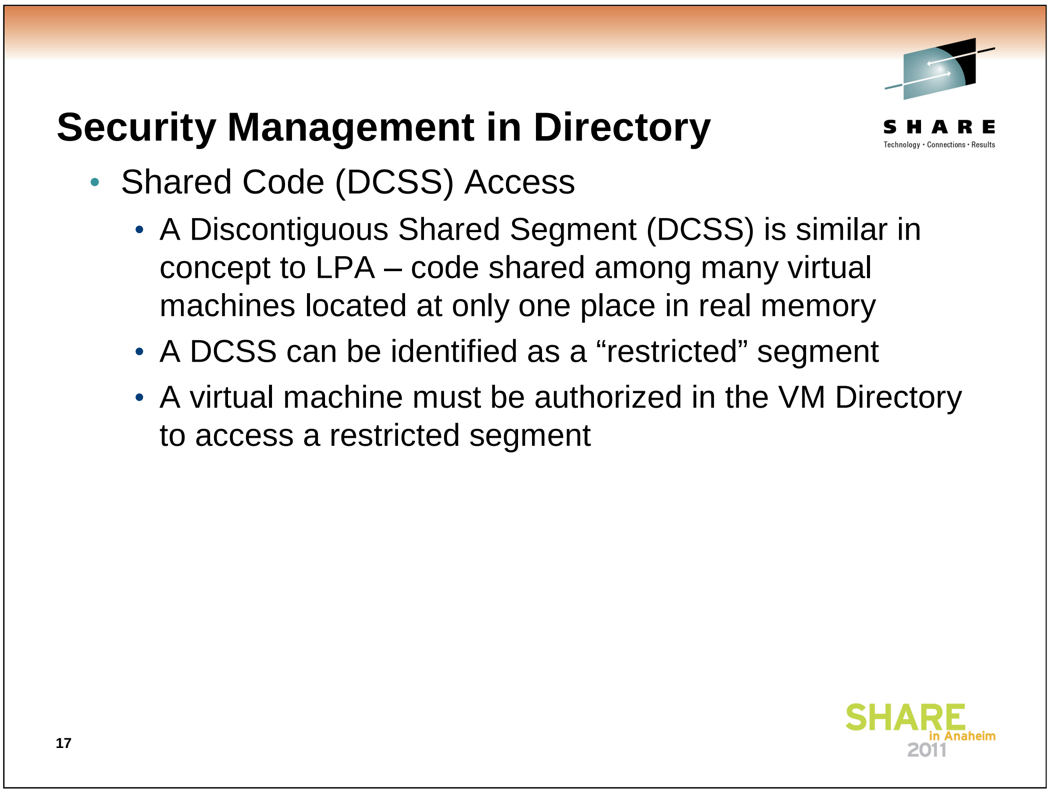
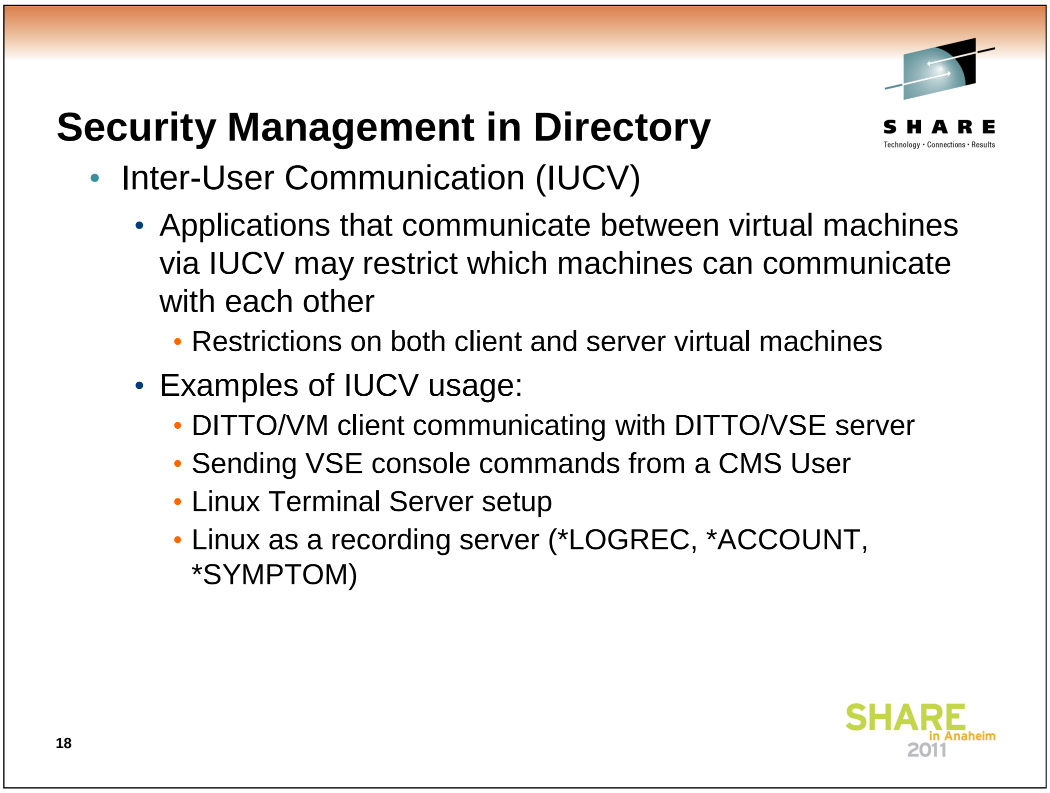


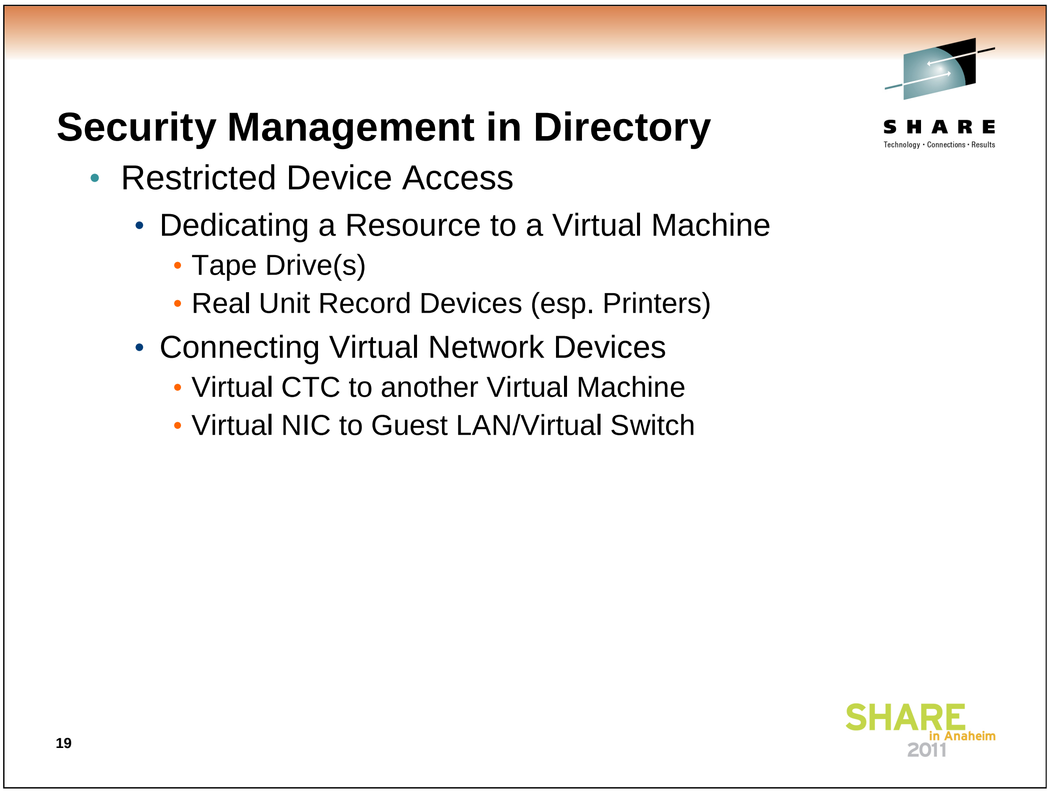
Security Management in Directory

- Shared Code (DCSS) Access
  - A Discontiguous Shared Segment (DCSS) is similar in concept to LPA – code shared among many virtual machines located at only one place in real memory
  - A DCSS can be identified as a “restricted” segment
  - A virtual machine must be authorized in the VM Directory to access a restricted segment



Security Management in Directory

- Inter-User Communication (IUCV)
  - Applications that communicate between virtual machines via IUCV may restrict which machines can communicate with each other
    - Restrictions on both client and server virtual machines
  - Examples of IUCV usage:
    - DITTO/VM client communicating with DITTO/VSE server
    - Sending VSE console commands from a CMS User
    - Linux Terminal Server setup
    - Linux as a recording server (*LOGREC, *ACCOUNT, *SYMPTOM)

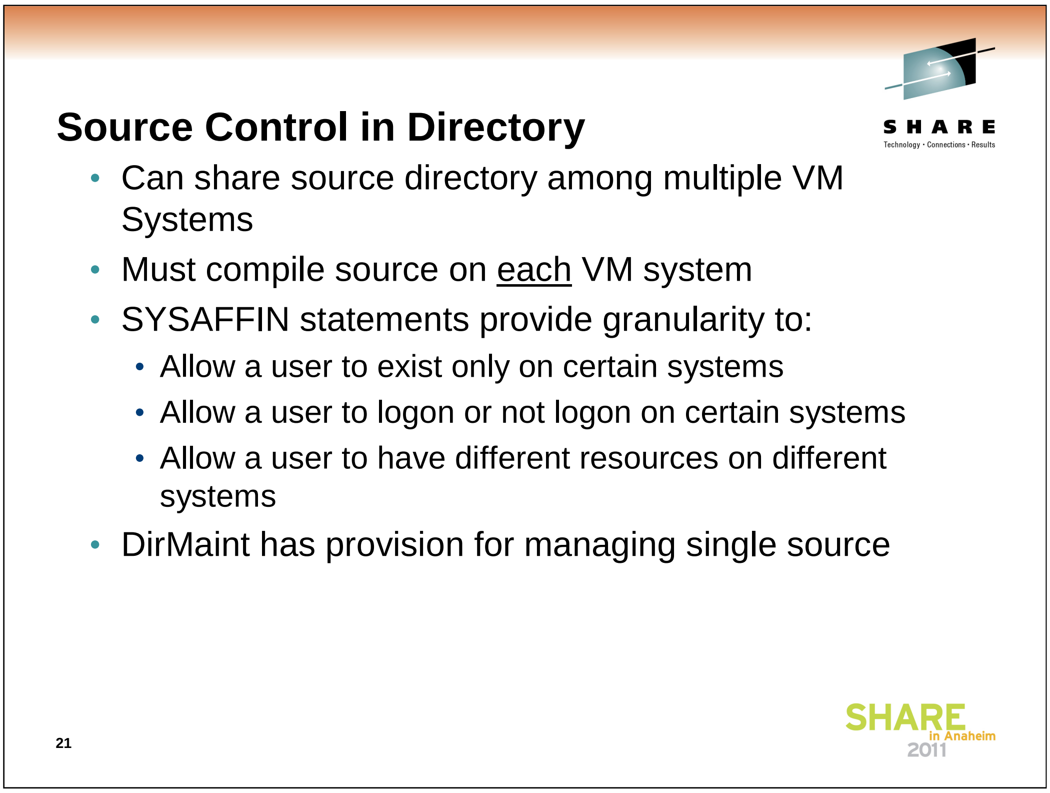


Security Management in Directory

- Restricted Device Access
  - Dedicating a Resource to a Virtual Machine
    - Tape Drive(s)
    - Real Unit Record Devices (esp. Printers)
  - Connecting Virtual Network Devices
    - Virtual CTC to another Virtual Machine
    - Virtual NIC to Guest LAN/Virtual Switch

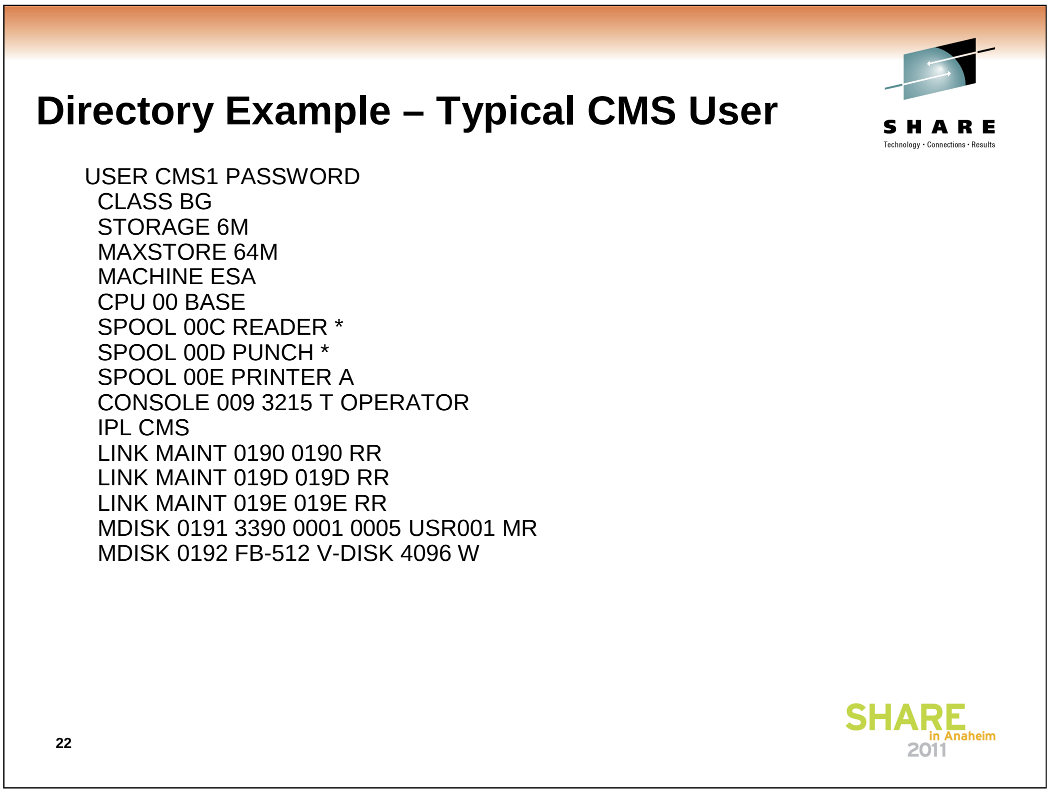
Command Classes restrict the ATTACH command to Class B users. The COUPLE command (for connecting Virtual NICs to a Guest Lan or VSwitch) is a general user command, since the administrator can limit who connects to a Guest Lan or VSwitch

Source Control in Directory



Source Control in Directory

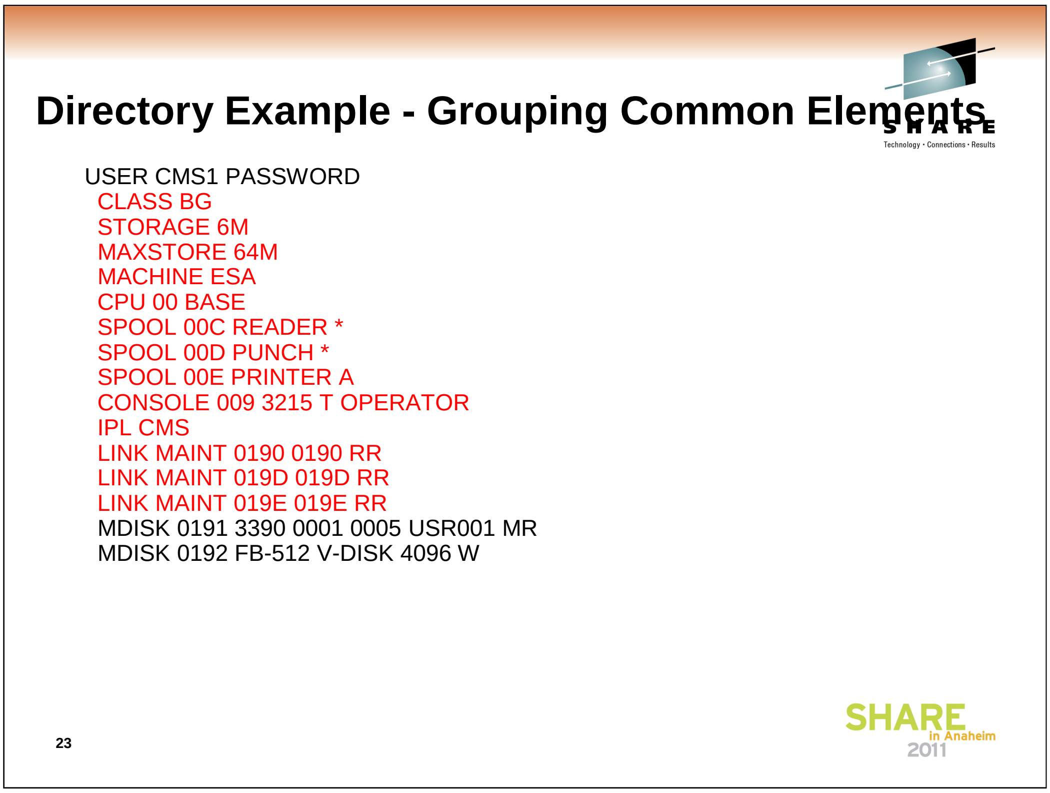
- Can share source directory among multiple VM Systems
- Must compile source on each VM system
- SYSAFFIN statements provide granularity to:
  - Allow a user to exist only on certain systems
  - Allow a user to logon or not logon on certain systems
  - Allow a user to have different resources on different systems
- DirMaint has provision for managing single source



Directory Example – Typical CMS User

```
USER CMS1 PASSWORD
  CLASS BG
  STORAGE 6M
  MAXSTORE 64M
  MACHINE ESA
  CPU 00 BASE
  SPOOL 00C READER *
  SPOOL 00D PUNCH *
  SPOOL 00E PRINTER A
  CONSOLE 009 3215 T OPERATOR
  IPL CMS
  LINK MAINT 0190 0190 RR
  LINK MAINT 019D 019D RR
  LINK MAINT 019E 019E RR
  MDISK 0191 3390 0001 0005 USR001 MR
  MDISK 0192 FB-512 V-DISK 4096 W
```

This is an example of a typical virtual machine setup for a user running the CMS operating system



Directory Example - Grouping Common Elements

```
USER CMS1 PASSWORD
 CLASS BG
 STORAGE 6M
 MAXSTORE 64M
 MACHINE ESA
 CPU 00 BASE
 SPOOL 00C READER *
 SPOOL 00D PUNCH *
 SPOOL 00E PRINTER A
 CONSOLE 009 3215 T OPERATOR
 IPL CMS
 LINK MAINT 0190 0190 RR
 LINK MAINT 019D 019D RR
 LINK MAINT 019E 019E RR
 MDISK 0191 3390 0001 0005 USR001 MR
 MDISK 0192 FB-512 V-DISK 4096 W
```

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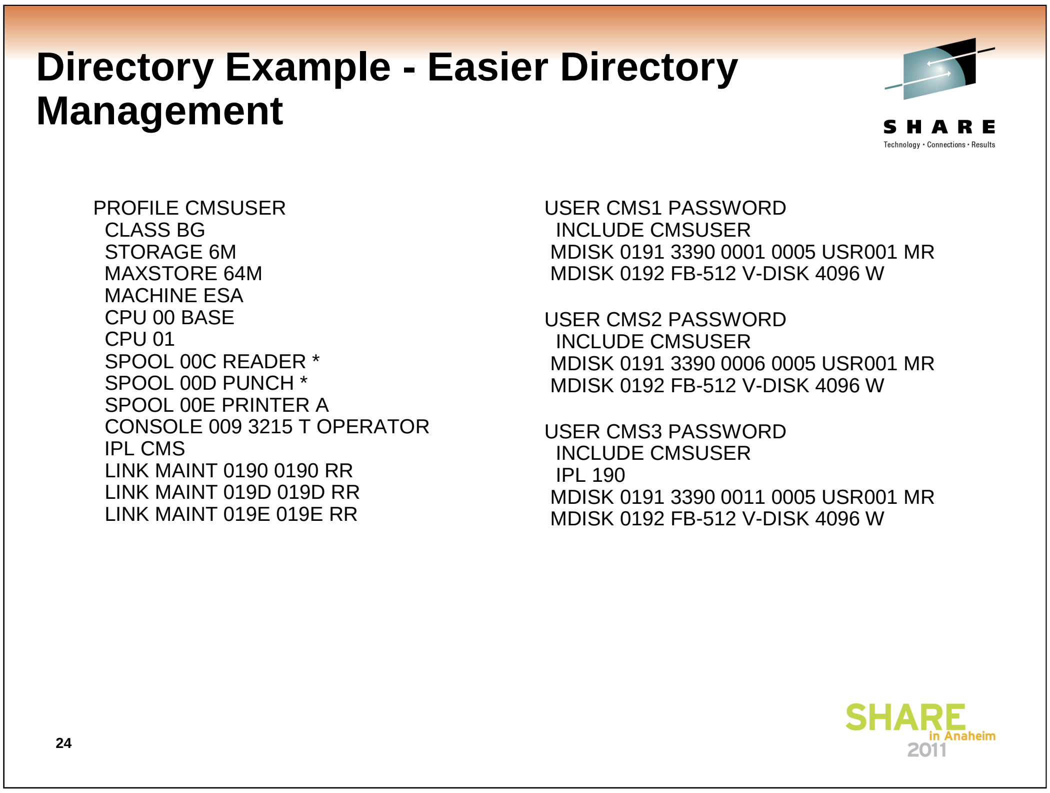
When you identify common elements for a group of virtual machines, they can be grouped into a common “profile”



Directory Example - Easier Directory Management

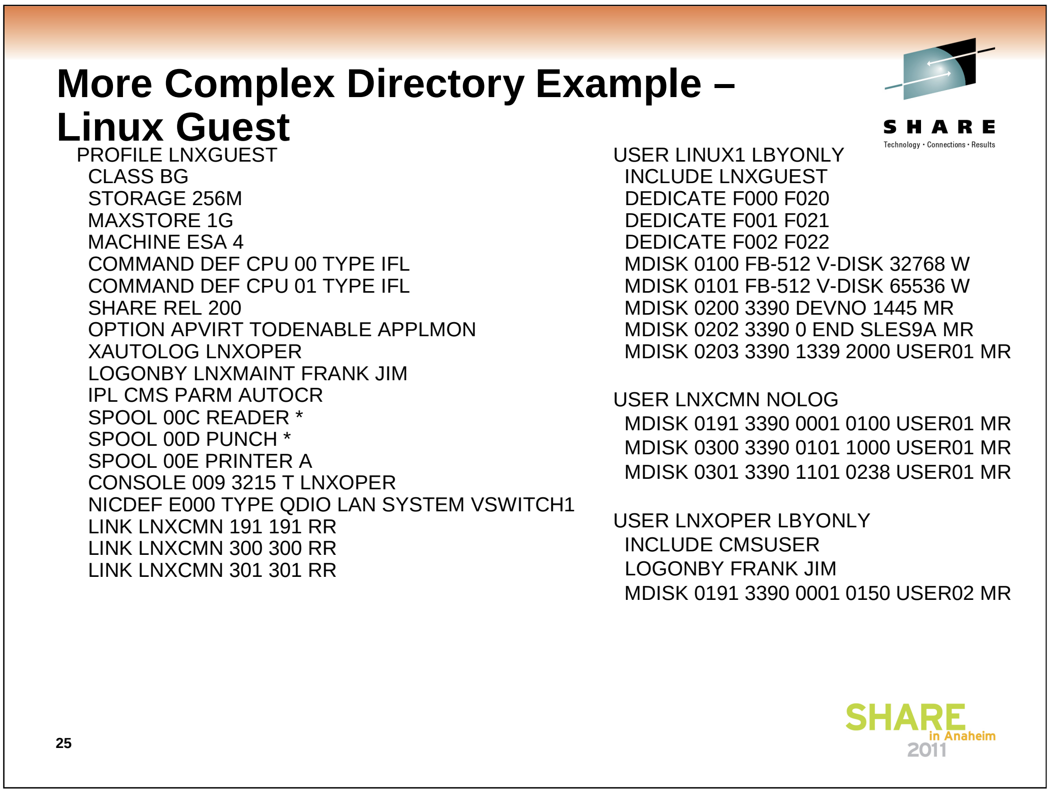
```
PROFILE CMSUSER
  CLASS BG
  STORAGE 6M
  MAXSTORE 64M
  MACHINE ESA
  CPU 00 BASE
  CPU 01
  SPOOL 00C READER *
  SPOOL 00D PUNCH *
  SPOOL 00E PRINTER A
  CONSOLE 009 3215 T OPERATOR
  IPL CMS
  LINK MAINT 0190 0190 RR
  LINK MAINT 019D 019D RR
  LINK MAINT 019E 019E RR
```

```
USER CMS1 PASSWORD
  INCLUDE CMSUSER
 MDISK 0191 3390 0001 0005 USR001 MR
 MDISK 0192 FB-512 V-DISK 4096 W

USER CMS2 PASSWORD
  INCLUDE CMSUSER
 MDISK 0191 3390 0006 0005 USR001 MR
 MDISK 0192 FB-512 V-DISK 4096 W

USER CMS3 PASSWORD
  INCLUDE CMSUSER
  IPL 190
 MDISK 0191 3390 0011 0005 USR001 MR
 MDISK 0192 FB-512 V-DISK 4096 W
```

By referring to a PROFILE in the virtual machine entry, you can update the profile and that change will be reflected each virtual machine using the profile. Entries in a profile can be overridden by explicit definitions in the virtual machine definition (note USER CMS3)



More Complex Directory Example – Linux Guest

```
 PROFILE LNXGUEST
   CLASS BG
   STORAGE 256M
   MAXSTORE 1G
   MACHINE ESA 4
   COMMAND DEF CPU 00 TYPE IFL
   COMMAND DEF CPU 01 TYPE IFL
   SHARE REL 200
   OPTION APVIRT TODENABLE APPLMON
   XAUTOLOG LNXOPER
   LOGONBY LNXMAINT FRANK JIM
   IPL CMS PARM AUTOCR
   SPOOL 00C READER *
   SPOOL 00D PUNCH *
   SPOOL 00E PRINTER A
   CONSOLE 009 3215 T LNXOPER
   NICDEF E000 TYPE QDIO LAN SYSTEM VSWITCH1
   LINK LNXCMN 191 191 RR
   LINK LNXCMN 300 300 RR
   LINK LNXCMN 301 301 RR
```

```
USER LINUX1 LBYONLY
  INCLUDE LNXGUEST
  DEDICATE F000 F020
  DEDICATE F001 F021
  DEDICATE F002 F022
  MDISK 0100 FB-512 V-DISK 32768 W
  MDISK 0101 FB-512 V-DISK 65536 W
  MDISK 0200 3390 DEVNO 1445 MR
  MDISK 0202 3390 0 END SLES9A MR
  MDISK 0203 3390 1339 2000 USER01 MR

USER LNXCMN NOLOG
  MDISK 0191 3390 0001 0100 USER01 MR
  MDISK 0300 3390 0101 1000 USER01 MR
  MDISK 0301 3390 1101 0238 USER01 MR

USER LNXOPER LBYONLY
  INCLUDE CMSUSER
  LOGONBY FRANK JIM
  MDISK 0191 3390 0001 0150 USER02 MR
```

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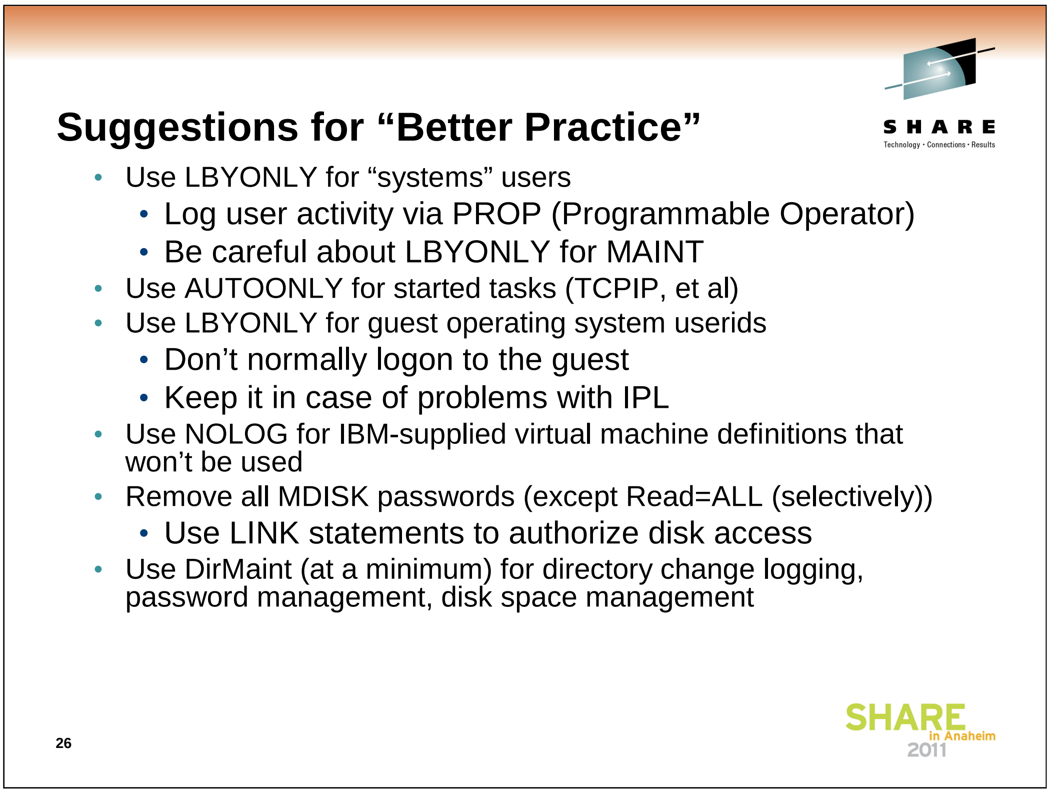
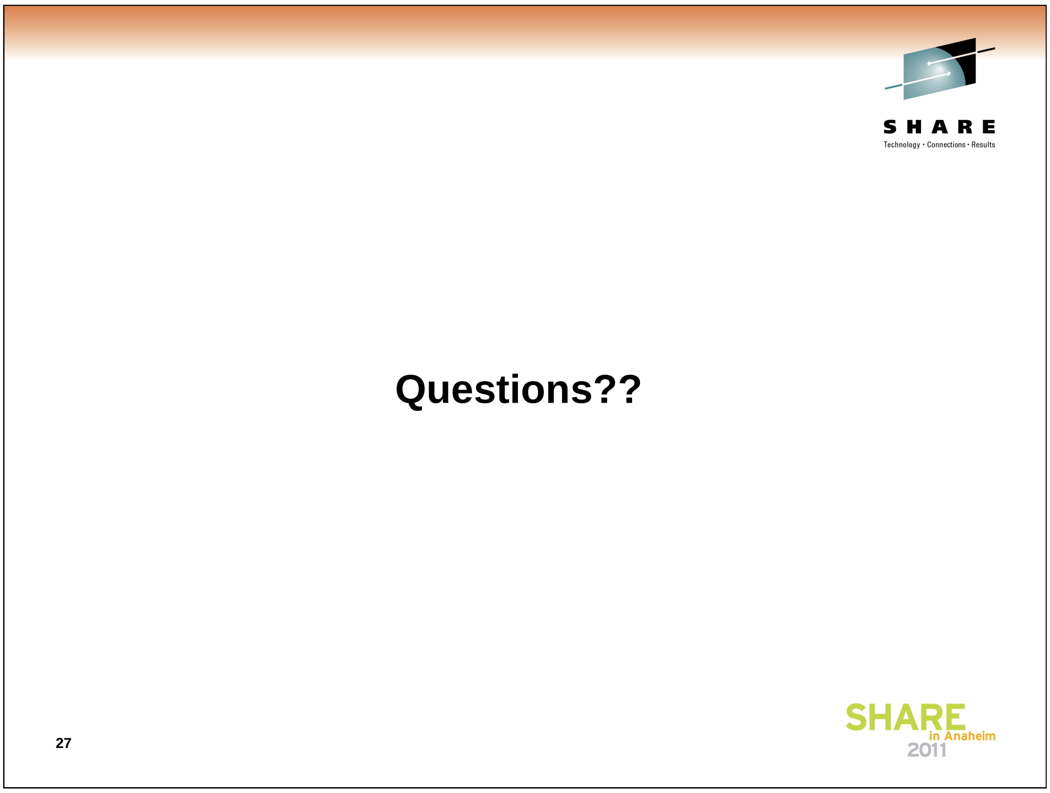
This example shows a virtual machine setup to run Linux using shared read-only minidisks as well as dedicated disks. These minidisks (contained in the profile) could contain executables (such as /boot and /usr) that can be shared between Linux instances and managed centrally.



Suggestions for “Better Practice”

- Use LBYONLY for “systems” users
  - Log user activity via PROP (Programmable Operator)
  - Be careful about LBYONLY for MAINT
- Use AUTOONLY for started tasks (TCPIP, et al)
- Use LBYONLY for guest operating system userids
  - Don’t normally logon to the guest
  - Keep it in case of problems with IPL
- Use NOLOG for IBM-supplied virtual machine definitions that won’t be used
- Remove all MDISK passwords (except Read=ALL (selectively))
  - Use LINK statements to authorize disk access
- Use DirMaint (at a minimum) for directory change logging, password management, disk space management

You may want to keep a password for TCPMAINT’s 191 for use with OBEYFILE commands. Be careful if you use LBYONLY with userid MAINT….if all the LOGONBY users have expired passwords, you may not be able to logon to MAINT.



Questions??

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