IBM Certification Study Guide AIX V4.3 System Administration

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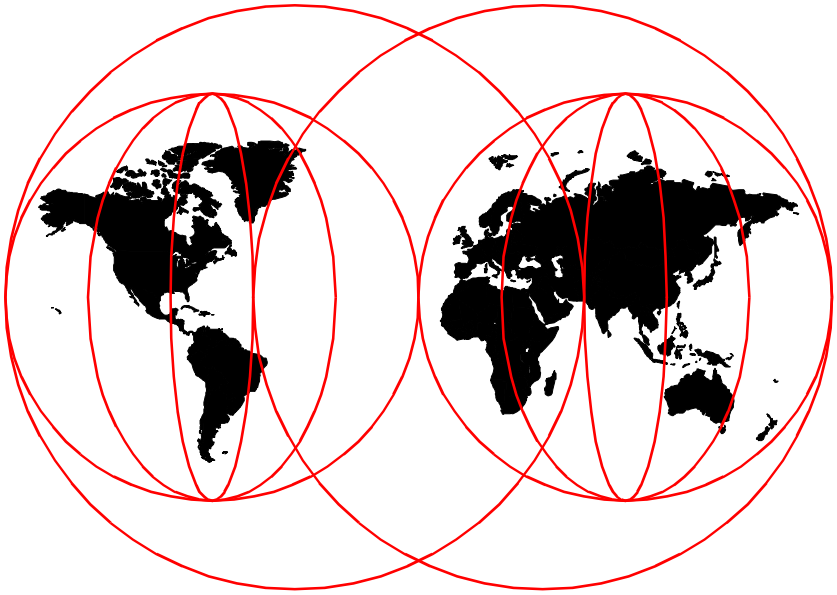

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SG24-5129-00

SG24-5129-00

International Technical Support Organization

IBM Certification Study Guide
AIX V4.3 System Administration

May 1999

Take Note!

Before using this information and the product it supports, be sure to read the general information in Appendix A, “Special Notices” on page 403.

First Edition (May 1999)

This edition applies to AIX Version 4.3 (5765-C34) and subsequent releases running on an RS/6000 server.

This document updated on May 30, 2001.

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Preface

The AIX & RS/6000 Certifications offered through the Professional Certification Program from IBM are designed to validate the skills required of technical professionals who work in the powerful and often complex environments of AIX and RS/6000. A complete set of professional certifications are available. They include:

- IBM Certified AIX User
- IBM Certified Specialist - RS/6000 Solution Sales
- IBM Certified Specialist - AIX V4.3 System Administration
- IBM Certified Specialist - AIX V4.3 System Support
- IBM Certified Specialist - RS/6000 SP
- IBM Certified Specialist - AIX HACMP
- IBM Certified Specialist - Domino for RS/6000
- IBM Certified Specialist - Web Server for RS/6000
- IBM Certified Specialist - Business Intelligence for RS/6000
- IBM Certified Advanced Technical Expert - RS/6000 AIX

Each certification is developed by following a thorough and rigorous process to ensure the exam is applicable to the job role and is a meaningful and appropriate assessment of skill. Subject Matter experts who successfully perform the job participate throughout the entire development process. These job incumbents bring a wealth of experience into the development process, thus, making the exams much more meaningful than the typical test that only captures classroom knowledge. These experienced Subject Matter experts ensure the exams are relevant to the *real world* and that the test content is both useful and valid. The result of this certification is the value of appropriate measurements of the skills required to perform the job role.

This redbook is designed as a study guide for professionals wishing to prepare for the certification exam to achieve: IBM Certified Specialist - AIX V4.3 System Administration.

The system administration certification validates a broad scope of AIX administration skills and the ability to perform general AIX software system maintenance. The certification is applicable to AIX administration professionals who conduct the AIX problem determination and resolution activities needed to successfully support customers, or clients, in an AIX environment in order to maintain system reliability.

This redbook helps AIX administrators seeking a comprehensive and task-oriented guide for developing the knowledge and skills required for the certification. It is designed to provide a combination of theory and practical experience needed for a general understanding of the subject matter. It also provides sample questions that will help in the evaluation of personal progress and provide familiarity with the types of questions that will be encountered in the exam.

This book does not replace practical experience. Instead, it is an effective tool that, when combined with education activities and experience, can be a very useful preparation guide for the exam. Due to the practical nature of the certification content, this publication can also be used as a desk-side reference. So, whether you are planning to take the administration exam, or if you just want to validate your AIX system administration skills, this book is for you.

For additional information about certification and instructions on *How to Register* for an exam call IBM at 1-800-426-8322 or visit the Web site at:
`http://www.ibm.com/certify`

The Team That Wrote This Redbook

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Chapter 1. Certification Overview

This chapter provides an overview of the skill requirements needed to obtain an IBM AIX Specialist certification. The following chapters are designed to provide a comprehensive review of specific topics that are essential for obtaining the certification.

1.1 IBM Certified Specialist - AIX V4.3 System Administration

This certification validates the ability to install, configure, and perform a broad range of AIX system administrative activities. The certification is applicable to AIX System Administrators who are responsible for supporting end-users and the day-to-day operation of an AIX RS/6000 environment.

Certification Requirements (1 Test):
To attain the IBM Certified Specialist - AIX V4.3 System Administration certification, candidates must pass one test: *Test 181: AIX V4.3 System Administration*

Recommended Prerequisites:

- A minimum of six months experience administering in an AIX V4 system environment. Note: Exam 181 contains AIX V4 content up to and including AIX V4.3.
- One year of AIX or UNIX user experience.
- Training in AIX system administration or equivalent experience.

Registration for the Certification Exam:
For information about *How to Register* for the certification exam, please visit the following Web site:

`http://www.ibm.com/certify`

1.1.1 AIX V4.3 System Administration Test 181 Objectives

The following objectives were used as a basis when the certification exam was developed. Some of these topics appear in this publication in a different order to help with the learning process.

Section 1 - Installation and Configuration

1. Installation
   - Install Base Operating System
   - Install LPPs
   - Apply software updates
   - Upgrade Operating System
   - Create and install a mksysb
   - Install software fixes
2. Configuration
   - Perform initial configurations (for example: networks, paging space, date/time, root password, and so on).
   - Configure printers and queues (for example: add, change, show, or delete printers and queues).
   - Configure and manage resources (for example: manage cron, configure skulkers, configure power management).
   - Configure devices (for example: `cfgmgr`, tty, parallel and manual devices).
   - Configure subsystems and subservers (for example: start/stop system resource manager).
   - Configure and monitor logs (for example: errord, syslogd, and so on).

Section 2 - Problem Determination

- Troubleshoot problems with hardware installation (for example: cable connections).
- Troubleshoot problems with software installation (LED hang, system hang).
- Troubleshoot problems with software (disk space, prereqs, `lslpp`, and so on).
- Troubleshoot hardware (for example: hardware parameters, `cfgmgr`, ODM tools).
- Evaluate performance and resource problems (for example: check log files, skulkers, `ps -ef`).

Section 3 - System and User Maintenance

1. User Maintenance
    - Add, delete, and modify users
2. Storage Maintenance
    - Work with Volume Groups (add, import, remove, export, modify, list, and so on)
    - Work with physical volumes (add, list)
    - Work with logical volumes (add, remove modify, list, and so on)
    - Work with filesystems (for example: create, remove, modify, list, and so on)
    - Modify paging space (increase size, add, remove, activate, list, and so on)
3. Storage Maintenance Problem Determination
    - Troubleshoot filesystem problems (for example: mount/unmount problems, filesystem full, and so on)
    - Troubleshoot paging space problems (for example: low paging space conditions)
    - Troubleshoot device related problems (for example: FS not available at IPL, VG not varying on IPL, SCSI device problems, and so on)
4. Backup and Recovery
    - Back up the system
    - Back up the applications
    - Back up the application data files
    - Restore files from tape
    - Establish a backup and recovery process based upon customer requirements
    - Reboot servers (gracefully)

Section 4 - Communications

1. TCP/IP
    - Work with TCP/IP daemons (for example: start and stop TCP/IP daemons)
    - Create interface (set IP address, set subnet mask, config DNS)
    - Configure interface (define node, gateway)

- Modify interface (change IP parameters)
- Perform TCP/IP troubleshooting (for example: daemons will not start/stop, cannot Telnet to server, user cannot log on to server, and so on)

2. NFS
   - Work with NFS (for example: start and stop NFS)
   - Export directory (`exportfs`)
   - Mount remote file system

Section 5 - System Performance

- Manage CPU and memory resources (for example: display CPU / Memory usage, start/stop a processor, and so on)
- Manage I/O performance resources
- Manage disk/data (partitions, RAID, mirroring, defragmenting file systems, and so on)

1.2 Certification Education Courses

Courses are offered to help you prepare for the certification tests. These courses are recommended, but not required, before taking a certification test. At the publication of this guide, the following courses are available. For a current list, please visit the following Web site:

`http://www.ibm.com/certify`

AIX Version 4 System Administration	
Course Number	Q1114 (USA), AU14 (Worldwide)
Course Duration	Five days
Course Abstract	Learn the basic system administration skills to support AIX RS/6000 running the AIX Version 4 operating system. Build your skills in configuring and monitoring a single CPU environment. Administrators who manage systems in a networked environment should attend additional LAN courses.
Course Content	•Install the AIX Version 4 operating system, software bundles, and filesets •Perform a system startup and shutdown •Understand and use AIX system management tools •Configure ASCII terminals and printer devices •Manage physical and logical volumes •Perform file systems management •Create and manage user and group accounts •Use backup and restore commands •Use administrative subsystems, including cron, to schedule system tasks and security to implement customized access of files and directories

AIX Version 4.3 Advanced System Administration	
Course Number	Q1116 (USA), AU16 (Worldwide)
Course Duration	Five days
Course Abstract	Learn how to identify possible sources of problems on stand-alone configurations of the RS/6000 and perform advanced system administration tasks.
Course Content	•Identify the different RS/6000 models and architects •Explain the ODM purpose for device configuration •Interpret system initialization and problems during the boot process •Customize authentication and set up ACLs •Identify the TCB components, commands, and their use •Obtain a system dump and define saved data •Identify the error logging facility components and reports •List ways to invoke diagnostic programs •Customize a logical volume for optimal performance and availability •Manage a disk and the data under any circumstance •Use the standard AIX commands to identify potential I/O, disk, CPU, or other bottlenecks on the system •Customize SMIT menus and define how SMIT interacts with the ODM •Define the virtual printer database and potential problems •List the terminal attributes and create new terminfo entries •Define the NIM installation procedure

AIX Version 4 Configuring TCP/IP and Accessing the Internet	
Course Number	Q1107 (USA), AU07 or AU05 (Worldwide)
Course Duration	Five days
Course Abstract	•Learn how to perform TCP/IP network configuration and administration on AIX Version 4 RS/6000 systems. •Learn the skills necessary to begin implementing and using NFS, NIS, DNS, network printing, static and dynamic routing, SLIP and SLIPLOGIN, Xstations, and the Internet.
Course Contents	•Describe the basic concepts of TCP/IP protocols and addressing •Explain TCP/IP broadcasting and multicasting •Configure, implement, and support TCP/IP on an IBM RS/6000 system •Use networking commands for remote logon, remote execution, and file transfer •Configure SLIP and SLIPLOGIN •Use SMIT to configure network printing •Connect multiple TCP/IP networks using static and dynamic routing •Implement DNS, NFS, and NIS •Perform basic troubleshooting of network problems •Configure an Xstation in the AIX environment •Explain how to access Internet services •Understand and support TCP/IP •Plan implementation of NFS •Support LAN-attached printers •Support AIX networking •Determine network problems •Implement network file systems

1.3 Education on CD: IBM AIX Essentials

The new IBM AIX Essentials series offers a dynamic training experience for those who need convenient and cost-effective AIX education. The series consists of five new, content rich, computer-based multimedia training

courses based on highly acclaimed, instructor-led AIX classes that have been successfully taught by IBM Education and Training for years.

To order, and for more information and answers to your questions:

- In the U.S., call 800-IBM-TEACH (426-8322) or use the online form at the following URL: `http://www-3.ibm.com/services/learning/aix/#order`
- Outside the U.S., contact your IBM Sales Representative or
- Contact an IBM Business Partner.

Chapter 2. System Startup Problem Handling

This chapter discusses the boot process and the common problems that you might encounter while the system is in the initialization phase. It also covers the common commands that are used to manipulate the elements associated with the boot process.

Upon completeing this chapter you should be able to:

- Understand the basics of the boot process and be able to perform an orderly system shutdown
- Determine and control the devices involed in the boot process
- Access the AIX error log
- Trouble shoot boot problems
- Understand and know by memory basic LED error codes

2.1 Key Commands Used Throughout the Chapter

The following is a list of the important commands that are used throughout this chapter.

`alog` Used to maintain and manage log files. Refer to 2.4.1, “Using the alog Command” on page 12 for further details.

`cfgmgr` Configures devices and optionally installs device software into the system. Refer to 2.4.2, “Using the cfgmgr Command” on page 15 for further details.

`last` Displays all the previous logins and logoffs that still have entries in /var/adm/wtmp file. Refer to 2.4.3, “Using the last Command” on page 17 for further details.

`bootlist` Displays and alters the list of boot devices available to the system. Refer to 2.4.4, “Using the bootlist Command” on page 19 for further details.

`uptime` Shows how long the system has been up. Refer to 2.4.5, “Using the uptime Command” on page 21 for further details.

`mpcfg` Enables a user with root authority to manage service information. Refer to 2.4.6, “Using the mpcfg Command” on page 22 for further details.

`shutdown` Used to shut down the system. Refer to 2.4.7, “Using the shutdown Command” on page 24 for further details.

2.2 Boot Process

During the boot process, the system tests the hardware, loads and runs the operating system, and configures devices. To boot the operating system, the following resources are required:

- A boot image that can be loaded after the machine is turned on or reset.
- Access to the root and /usr file systems.

There are three types of system boots:

- Hard Disk Boot

  A machine is started for normal operations with the key in the normal position. On PCI-based systems with no key locking, this is the default startup mode.

- Diskless Network Boot

  A diskless or dataless workstation is started remotely over a network. A machine is started for normal operations with the key in the normal position. One or more remote file servers provide the files and programs that diskless or dataless workstations need to boot.

- Service Boot

  A machine is started from a hard disk, network, tape, or CD-ROM with the key set in the service position. This condition is also called maintenance mode. In maintenance mode, a system administrator can perform tasks, such as installing new or updated software and running diagnostic checks.

During a hard disk boot, the boot image is found on a local disk created when the operating system was installed. During the boot process, the system configures all devices found in the machine and initializes other basic software required for the system to operate (such as the Logical Volume Manager). At the end of this process, the file systems are mounted and ready for use.

The same general requirements apply to diskless network clients. They also require a boot image and access to the operating system file tree. Diskless network clients have no local file systems and get all their information by way of remote access.

The system finds all information necessary for the boot process on its disk drive. When the system is started by turning on the power switch (a cold boot) or restarted with the reboot or shutdown commands (a warm boot), a number

of events must occur before the system is ready for use. These events can be divided into the following phases:

1. Read Only Storage (ROS) Kernel Init Phase

   During this stage, problems with the motherboard are checked, and the ROS initial program load searches for the bootlist. Once the bootlist is found, the boot image is read into the memory, and system initialization starts.

2. Base Device Configuration Phase

   All devices are configured in this phase with the help of `cfgmgr` command.

3. System Boot Phase

   In this phase of the boot process, all the logical volumes are varied on, paging is started, and the /etc/inittab file is processed.

2.3 Power On Sequence LEDs and Audio Signals

Several MCA based RISC/6000 systems have LED displays to show what phase of the boot process the system is going through. If something goes wrong, you can interpret the LED codes and take the appropriate action to rectify the problem.

Exam Pointer

As a specialist, memorizing the error codes enables you to quickly get to the heart of critical system problems. and therefore one of the sections of the exam that requires memorization.

PCI RISC/6000 systems use sounds and graphics to show the different phases of the boot process. For example, as soon as you power on the system, an audio beep is produced when the processor is found to be active, the PowerPC logo is shown when the system memory checking is completed, and Device logos are shown for all devices that have a valid address. At the end of the device logo display, if the system ROS is not corrupted, an audio beep is again produced.

System administrators solve the problems that they might encounter during the startup process using these indicators.

2.4 Useful Commands

The commands that are used to manage system startup, shutdown, and the related tasks are discussed in the following sections.

2.4.1 Using the alog Command

There may be instances when the system administrator must trace the boot process and find out whether something did go wrong with the system. AIX provides the system administrator with an excellent tool to monitor these problems with the help of the `alog` command.

The `alog` command can maintain and manage logs. It reads standard input, writes to standard output, and copies the output into a fixed-size file. This file is treated as a circular log. If the file is full, new entries are written over the oldest existing entries.

The rc.boot script explicitly redirects boot information through the `alog` command to a file /var/adm/ras/bootlog. If something goes wrong with the system, the system administrator can boot the system in single-user mode (maintenance mode) and access these logs through the `alog` command to see at what stage the system is failing. A part of the rc.boot script is shown below to illustrate how the logging mechanism has been incorporated.

```
# Error Recovery if customized data is zero

[ -f /no_sbase ] && {
echo "rc.boot: executing savebase recovery procedures" \
>>/tmp/boot_log
X=`ODMDIR=/mnt/etc/objrepos odmshow CuDv |\
fgrep population`
count=`echo $X | cut -f2 -d' '`
[ $count -ne 0 ] && {
/usr/sbin/savebase -o /mnt/etc/objrepos
[ $? -ne 0 ] && loopled 0x546
mount /var# so that reboot can log
echo "savebase recovery reboot" \
>>/tmp/boot_log
cat /tmp/boot_log | alog -q -t boot
reboot
}
}
```

The `alog` command works with log files that are specified on the command line or with logs that are defined in the `alog` configuration database.

The most common flags used with the alog command and their description are given in Table 1.

Table 1. alog Command Flags

Flag	Description
-f LogFile	Specifies the name of a log file. If the specified LogFile does not exist, one is created. If the alog command is unable to write to LogFile, it writes to /dev/null.
-L	Lists the log types currently defined in the alog configuration database. If you use the -L flag with the -t LogType flag, the attributes for a specified LogType are listed.
-o	Lists the contents of LogFile. Writes the contents of LogFile to standard output in sequential order.
-q	Copies standard input to LogFile but does not write to standard output.
-t LogType	Identifies a log defined in the alog configuration database. The alog command gets the log's file name and size from the alog configuration database.

These logs can be maintained by using either SMIT or by using the alog command directly. The general use of the alog command is as follows:

2.4.1.1 To Show the Contents of a Log File

In order to list the contents of a log file, use the command:

```
alog -f LogFile [ -o ]
```

2.4.1.2 To Log Data to a Specified Log File

You can change the default file that is used to log the activities by using the following command:

```
alog -f LogFile | [ [ -q ] [ -s Size ] ]
```

2.4.1.3 To Display the Verbosity Value of a Specified Log Type

The verbosity value specifies the depth of information that is written to a log. In order to display the verbosity value of a log, use the following command:

```
alog -t LogType -V
```

2.4.1.4 To Change the Attributes of a Specified Log Type

You can use the different attributes of a log type by using the following command:

```
alog -C -t LogType [ -f LogFile ] [ -s Size ] [ -w Verbosity ]
```

2.4.1.5 To Display the Current Attributes of a Specified Log Type

Before you can change the attributes of a log it is recommended to view what the current attributes are. Use the following command to display the current attributes of a log type:

```
alog -L [ -t LogType ]
```

In order to view the boot log, you can either use SMIT or use the `alog` command directly. Follow the sequence in 2.4.1.6, “Viewing the Boot Log” on page 14 to view the contents of the boot log.

2.4.1.6 Viewing the Boot Log

You can view the boot log by either using the SMIT fastpath `smitty alog_show` and giving the name of the log you want to view, or you can use the command. In order to view a log using the `alog` command, determine what predefined logs are available to you.

Use the `alog -L` command to view the logs defined in the `alog` database. On the command line enter:

```
# alog -L
boot
bosinst
nim
dumpsymp
```

In order to view the boot log (the log that holds boot information) enter:

```
# alog -o -t boot
---------
attempting to configure device 'fda0'
invoking /usr/lib/methods/cfgfda_isa -2 -l fda0
return code = 0
****************** stdout ***********
fd0

****************** no stderr ***********
--------------------------------------------------------------------------
invoking top level program -- "/etc/methods/starttty"
return code = 0
****************** no stdout ***********
****************** no stderr ***********
--------------------------------------------------------------------------
invoking top level program -- "/etc/methods/startsmt"
return code = 0
****************** no stdout ***********
****************** no stderr ***********
```

```
-------------------------------------------------------------------------
invoking top level program -- "/etc/methods/load_blockset_ext"
return code = 0
****************** no stdout ***********
****************** no stderr ***********
-------------------------------------------------------------------------
invoking top level program -- "/usr/lib/methods/defaio"
return code = 0
****************** no stdout ***********
****************** no stderr ***********
-------------------------------------------------------------------------
calling savebase
return code = 0
****************** no stdout ***********
****************** no stderr ***********
Starting AIX Windows Desktop.....
Saving Base Customize Data to boot disk
Starting the sync daemon
Starting the error daemon
System initialization completed.
Starting Multi-user Initialization
 Performing auto-varyon of Volume Groups
 Activating all paging spaces
swapon: Paging device /dev/hd6 activated.
/dev/rhd1 (/home): ** Unmounted cleanly - Check suppressed
 Performing all automatic mounts
Multi-user initialization completed
```

Any errors that are encountered will be logged into this file. However, the `alog` file has no concurrency control; therefore, if multiple processes try to write to the same file at the same time, the contents of the log file might not be as anticipated. Additionally, it is a cyclic file; so, when its size gets to the maximum, it is overwritten.

2.4.2 Using the cfgmgr Command

During the boot process, the system has to determine what resources are available to it. For example, the system has to determine what kind of bus the system is using, what type of devices are attached to the system, where the rootvg resides, and so on. The configuration of these devices is handled by the BOS command `cfgmgr`. The `cfgmgr` command configures devices and optionally installs device software into the system.

The general syntax of the `cfgmgr` command is as follows:

```
cfgmgr [ -f | -s | -p Phase ] [ -i Device ] [ -l Name ] [ -v ]
```

The most commonly used flags and their description are given in Table 2:

Table 2. cfgmgr Command Flags

Flag	Description
-f	Specifies that the `cfgmgr` command runs the phase 1 configuration rules. This flag is not valid at run time (after system start).
-i Device	Specifies the location of the installation medium.
-l Name	Specifies the named device to configure along with its children.
-p Phase	Specifies the phase that the `cfgmgr` command runs.
-s	Specifies that the `cfgmgr` command follows the phase 2 configuration rules.
-v	Specifies verbose output. The `cfgmgr` command writes information about what it is doing to standard output.

The devices to be configured are controlled by the Configuration Rules object class, which is part of the Device Configuration database. Each configuration rule specifies three items:

- The full path name of an executable program to run.
- When to run the program (in relation to the other rules).
- In which phase to run the program.

During system boot, the `cfgmgr` command configures all the devices that are necessary to use the system. System boot is a two-step process.

- Phase 1

  Phase 1 begins when the kernel is brought into the system, and the boot file system is initialized. During this phase, the `cfgmgr` command is invoked specifying this as phase 1 by using the -f flag. The `cfgmgr` command runs all of the phase 1 configuration rules, which results in the base devices being configured.

- Phase 2

  In this phase, the `cfgmgr` command is called with the -s flag.

The `cfgmgr` command recognizes three phases of configuration rules:

- Phase 1
- Phase 2 (second boot phase for normal boot)
- Phase 3 (second boot phase for service boot)

Normally, the `cfgmgr` command runs all the rules for the phase specified during invocation (for example, phase 1 rules for the -f flag). However, if the -l flag is issued, the `cfgmgr` command configures only the named device and its children.

If the `cfgmgr` command is invoked without a phase option (for example, without the -f,-s, or -p flags), then the command runs the phase 2 rules. The only way to run the phase 3 rules is with the -p flag.

If you invoke the `cfgmgr` command with the -i flag, the command attempts to install device software automatically for each new detected device. The device variable of the -i flag specifies where to find the installation medium. The installation medium can be a hardware device (such as a tape or diskette drive), a directory that contains installation images, or the installation image file itself.

Technical Traps

To protect the Configuration database, the `cfgmgr` command is not interruptible. Stopping this command before execution is complete could result in a corrupted database.

The `cfgmgr` command configures only those devices at the system startup that are powered on and are self configurable, such as SCSI drives, or ttys that have been defined in the inittab file. If you have some devices that were not powered on when the system started, the system will not make them available until you explicitly tell it to configure them. The syntax of the command is:

```
cfgmgr -v
```

It will produce an output similar to the `alog -o -t boot` command. See Section 3.2, “Configuring System Devices” on page 41.

2.4.3 Using the last Command

The `last` command is generally used to display, in reverse chronological order, all previous logins and logoffs recorded in the /var/adm/wtmp file. The /var/adm/wtmp file collects login and logout records as these events occur and retains them until the records are processed by the `acctcon1` and `acctcon2` commands as part of the daily reporting procedures. When the time daemon, timed, changes the system time, it logs entries in wtmp under the pseudo-user *date*. An entry starting with *date* | is logged before the change, and one starting with *date* { is logged after the change. This allows for

accurate accounting of logins that span a time change. The general syntax of the command is as follows:

```
last [ -f FileName ] [ -Number ] [ Name ... ] [ Terminal ... ]
```

The common flags used with `last` command are provided in Table 3.

Table 3. last Command Flags

Flag	Description
-Number	The number of lines to display in the output.
Name	Logins and logouts of the users specified by the name parameter.
Terminal	Login and logoffs from the terminals specified by the terminal parameter.

For example, if you want to find out when root logged on and off from the console, enter the command:

```
# last root console
root      pts/3 dummy Oct 23 12:27   still logged in.
root      lft0                              Oct 22 11:45   still logged in.
root      lft0                              Oct 22 09:46 - 11:27  (01:40)
root      pts/0        dummy                Oct 21 11:36 - System is halted
by system administrator.   (00:24)
root      pts/1        dummy.xyz.abc        Aug 08 13:05 - System is halted
by system administrator.   (02:17)
root      pts/0        dummy.xyz.abc        Aug 08 12:43 - System is halted
by system administrator.   (02:39)
root      lft0                               Sep 18 15:41 - System halted
abnormally.  (14203+20:56)
root      pts/1        dummy.xyz.abc        Sep 18 15:00 - System halted
abnormally.   (00:31)
root      pts/3        dummy.xyz.abc        Sep 18 12:05 - System halted
abnormally.  (14245+02:51)
root      pts/3        dummy.xyz.abc        Sep 18 12:04 - 12:05  (00:00)
root      pts/1        dummy.xyz.abc        Sep 18 11:50 - 12:04  (00:14)
root      pts/1        dummy.xyz.abc        Sep 16 13:32 - 11:11 (1+21:38)
root      pts/2        dummy.xyz.abc        Sep 16 11:35 - System is halted
by system administrator.   (00:04)
root      pts/0        dummy.xyz.abc        Sep 04 15:27 - System is halted
by system administrator.   (00:15)
root      lft0                               Sep 04 15:27 - 15:40  (00:13)
wtmp begins     Sep 04 15:11
```

The `last` command can also be used to determine when the system was last shutdown. The syntax of the command follows:

```
# last | grep shutdown
shutdown  pts/0                                Oct 22 09:23
shutdown  lft0                                 Oct 21 16:39
shutdown  pts/0                                Oct 21 13:41
shutdown  lft0                                 Sep 25 14:43
shutdown  pts/1                                Aug 08 15:22
shutdown  lft0                                 Sep 16 11:40
shutdown  ~                                    Sep 08 14:47
```

2.4.4 Using the bootlist Command

The `bootlist` command allows you to display and alter the list of boot devices from which the system may be booted. When the system is booted, it will scan the devices in the list and attempt to boot from the first device it finds containing a boot image. This command supports updating of the following:

Normal boot list The normal list designates possible boot devices for when the system is booted in normal mode.

Service boot list The service list designates possible boot devices for when the system is booted in service mode.

Previous boot device This entry designates the last device from which the system booted. Some hardware platforms may attempt to boot from the previous boot device before looking for a boot device in one of the other lists.

Support of these boot lists varies from platform to platform. Some platforms do not have bootlists. When searching for a boot device, the system selects the first device in the list and determines if it is bootable. If no boot file system is detected on the first device, the system moves on to the next device in the list. As a result, the ordering of devices in the device list is extremely important.

The general syntax of the command is as follows:

```
bootlist [ { -m Mode } [ -r ] [  -o  ] [ [ -i ] | [ [ -f File ] [ Device [
Attr=Value ... ] ... ] ] ]
```

The most common flags used with `bootlist` command are provided in Table 4.

Table 4. bootlist Command Flags

Flag	Description
-m mode	Specifies which boot list to display or alter. Possible values for the mode variable are normal, service, both, or prevboot.
-f File	Indicates that the device information is to be read from the specified file name.
-i	Indicates that the device list specified by the -m flag should be invalidated.
-o	Displays bootlist with the -m flag. Applies only to AIX Version 4.2 or later.
-r	Indicates to display the specified bootlist after any specified alteration is performed.

In order to display a boot list (Version 4.2 or later) use the command:

```
# bootlist -m normal -o
fd0
cd0
hdisk0
```

If you want to make changes to your normal boot list, use the command:

```
bootlist -m normal hdisk0 cd0
```

This will change the normal bootlist to indicate that when the system is booted, it will first attempt to boot from the floppy disk. If it cannot find a boot image in hdisk0 it will search the CD-ROM. Otherwise, it will instruct the system to provide an LED error code and wait for user intervention.

2.4.4.1 Boot Device Choices

The naming conventions that can be used in your boot list are provided in Table 5. Each device that you add to your bootlist must be in the AVAILABLE state. Otherwise, the `bootlist` command will fail, and you will encounter an error similar to:

```
0514-210 bootlist: Device xxxxx is not in the AVAILABLE state
```

Table 5. Valid Device Names for bootlist Command

Device	Description
fdxx	Diskette drive device logical names
hdiskxx	Physical volume device logical names
cdxx	SCSI CD-ROM device logical names
rmtxx	Magnetic tape device logical names
entxx	Ethernet adapter logical names
tokxx	Token Ring adapters logical names

2.4.5 Using the uptime Command

If you suspect that your system was shutdown and restarted, you can use the `uptime` command to find this out. The `uptime` command shows how long the system has been up. The general syntax of the command is as follows:

```
# uptime
05:10PM up 6 days, 21:45, 13 users, load average 4.00, 3.00, 0.00
```

The `uptime` command prints the current time, the length of time the system has been up, the number of users online, and the load average. The load

average is the number of runnable processes over the preceding 5, 10, or 15 minute intervals. The output of the `uptime` command is, essentially, the heading line provided by the `w` command.

2.4.6 Using the mpcfg Command

The `mpcfg` command enables a user with root authority to manage service information consisting of the service support and diagnostic flags (-S and -f flags), the modem and site configuration (-m flag), and the remote support phone numbers (-p flag).

The `mpcfg` command works only on multiprocessor systems with Micro Channel I/O. For IBM systems, this includes the IBM 7012 Model G Series, the IBM 7013 Model J Series, and the IBM 7015 Model R Series.

Exam pointer

The discussion about Micro Channel I/O may seem out of date now that PCI is used in every RS/6000 product, but many of the older Micro Channel machines are still in use and require specific skills. A specialist should know how to configure new and old hardware.

The general syntax of the command and the meaning of the flags are as follows:

2.4.6.1 Display Service Information

In order to display service information, you can use:

```
mpcfg -d { -f -m -p -S}
```

For example, in order to find out what the status is of your diagnostic flags, use the `mpcfg` command as shown in Figure 1.

```
 # mpcfg -df
Index   Name                                          Value
1       Remote Authorization                          0
2       Autoservice IPL                               0
3       BUMP Console                                  1
4       Dial-Out Authorization                        0
5       Set Mode to Normal When Booting               0
6       Electronic Mode Switch from Service Line      1
7       Boot Multi-user AIX in Service                0
8       Extended Tests                                0
9       Power On Tests in Trace Mode                  0
10      Power On Tests in Loop Mode                   0
11      Fast IPL                                      0
 #
```

Figure 1. Displaying Diagnostic Flags

2.4.6.2 Change Service Information

In order to change the service information, use the `mpcfg` command with the following combination of flags:

```
mpcfg -c { -f | -m | -p -S -w} Index Value...
```

For example, if you want to Fast IPL the system, you can change the value of the diagnostic flag as follows:

```
mpcfg -cf 11 1
```

This command will look up in the index (see Figure 1 on page 23) and will change the value of the eleventh item (that is Fast IPL) to 1. The next time the system is booted, the system will skip extensive hardware testing and will take less time to boot than normal.

2.4.6.3 Save or Restore Service Information

In order to store information about the flags, use the `mpcfg` command with the following syntax:

```
mpcfg { -r | -s }
```

The most commonly used command flags for the `mpcfg` command are listed in Table 6.

Table 6. mpcfg Command Flags

Flag	Description
-c	Changes the values of service information. The values that you want to modify are identified first by the flag -f, -m, -p, or -S, and then by their index (Index parameter) within this category.
-d	Displays the values of service information according to the -f, -m, -p, and -S flags set in the command. These values are displayed associated with their corresponding indexes and names.
-s	Saves the service information in the /etc/lpp/diagnostics/data/bump file.
-f	Indicates that the action (display or change) will be applied to the diagnostic flags.
-m	Indicates that the action (display or change) will be applied to the modem and site configuration.
-p	Indicates that the action (display or change) will be applied to the remote support phone numbers.
-S	Indicates that the action (display or change) will be applied to the service support flags.
-w	Indicates that the change will be applied to a password.

2.4.7 Using the shutdown Command

A system shutdown is controlled by a shell script that properly prepares a system with multiple users to be turned off or rebooted. An improper shutdown can have undesirable results on the system's integrity.

The general syntax of the `shutdown` command is as follows:

```
shutdown [ -d ] [ -F ] [ -h ] [ -i ] [ -k ] [ -m ] [ -p ] [ -r ] [ -t
mmddHHMM [ yy ] ] [ -v ] [ +Time [ Message ] ]
```

The common flags used with the `shutdown` command are provided in Table 7.

Table 7. shutdown Command Flags

Flag	Description
-d	Brings the system down from a distributed mode to a multiuser mode.
-F	Does a fast shutdown, bypassing the messages to other users, and brings the system down as quickly as possible

Flag	Description
-h	Halts the operating system completely; it is the same as the -v flag.
-i	Specifies interactive mode. Displays interactive messages to guide the user through the shutdown.
-k	Avoids shutting down the system.
-m	Brings the system down to maintenance (single user) mode.
-r	Restarts the system after being shutdown with the reboot command.
-v	Halts the operating system completely.

In order to perform a fast shutdown and restart the system, enter:

```
shutdown -Fr
```

You will see the message `shutdown completed`. at the end of this process before the reboot.

2.4.7.1 Adding Applications to the Shutdown Process

At times, it may be necessary to properly close down all the applications and other user processes without issuing a `kill` command to end the processes. You can achieve this by adding your desired commands and actions to a file named /etc/rc.shutdown. The /etc/rc.shutdown file is checked each time a `shutdown` command is issued. If the file exists, it will be run; otherwise, the system will perform a regular shutdown depending on the flags that are used to bring the system down.

Tips for the Pratitioner

/etc/rc.shutdown must be set as executable before it can called by the /usr/sbin/shutdown script.

Beginning with AIX 4.2.0, the /usr/sbin/shutdown script is changed to incorporate this file. A part of the /usr/sbin/shutdown script executing the rc.shutdown file is shown below:

```
if [ $nohalt = off ]
then
# /etc/rc.shutdown is for adminstrators to create for their
# own local needs.  If it is not successful, shutdown will
# abort.
if [ -x /etc/rc.shutdown ]
```

```
then
    sh /etc/rc.shutdown
     if [ $? -ne 0 ] ; then
dspmsg -s 1 shutdown.cat 60 \
"/etc/rc.shutdown failed.  Shutdown aborting.\n"
exit 1
    fi
fi
```

2.5 Troubleshooting Boot Problems

There are many contributing factors towards a system failure. A system can fail due to mishandling, if someone intentionally accesses and ends up corrupting it, when conditions, such as a power failure, corrupt the Boot Logical Volume (BLV), or a disk encounters many bad blocks under which the system becomes un-usable. Any of these conditions may prevent the system from restarting.

The sections that follow contain a discussion of the situations where the system will not boot and how to correct the problems.

Tips for the Pratitioner

You must have root authority to perform all these functions.

2.5.1 Accessing a System that Will Not Boot

If you are unable to boot your system, the first step is to access the system and see what is the probable cause of the failure. This procedure enables you to get a system prompt so that you may attempt to recover data from the system or perform corrective action that will enable the system to boot from the hard disk.

The following steps summarize the procedure for accessing a system that will not boot. For detailed information, see the *AIX Version 4.3 Installation Guide,* SC23-4112.

In order to access the system:

1. Turn on all attached external devices, such as terminals, CD-ROM drives, tape drives, monitors, and external disk drives before turning on the system unit. Turn on the system unit to allow the installation media to be loaded.

2. Insert Volume 1 of the installation media into the tape or CD-ROM drive and power the system unit off.
3. Turn the system key (if present) to the service position or alternatively press **F5** (or **5**) on PCI-based systems to boot from the tape or CD-ROM drive (during step 4).
4. Turn the system unit power switch to the on position. When booting from alternate media, a screen will appear (before the following figure) asking you to press a function key (such as **F1**) to select the proper display as the system console. Each display attached to the system will receive a function key number in order to identify it as the system console. The system begins booting from the installation media. After several minutes, C31 is displayed in the LED (if your system has an LED; otherwise, a screen similar to the one in Figure 2 is shown).

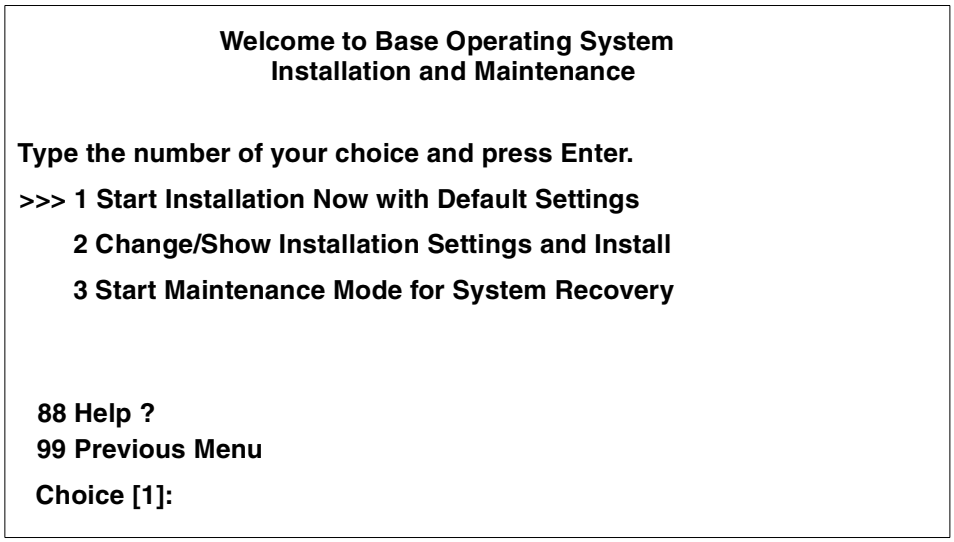

Figure 2. BOS Installation and Maintenance Screen

5. Select option 3, **Start Maintenance Mode for System Recovery**, and press **Enter**. A screen similar to Figure 3 is shown.

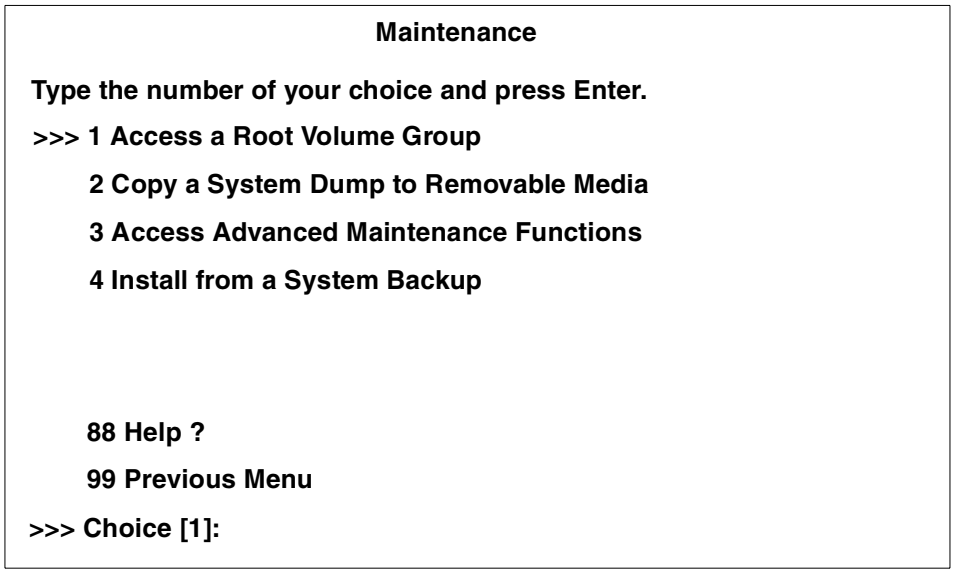

Figure 3. Maintenance Menu

6. Enter **1**, **Access a Root Volume Group**. A screen similar to Figure 4 is shown.

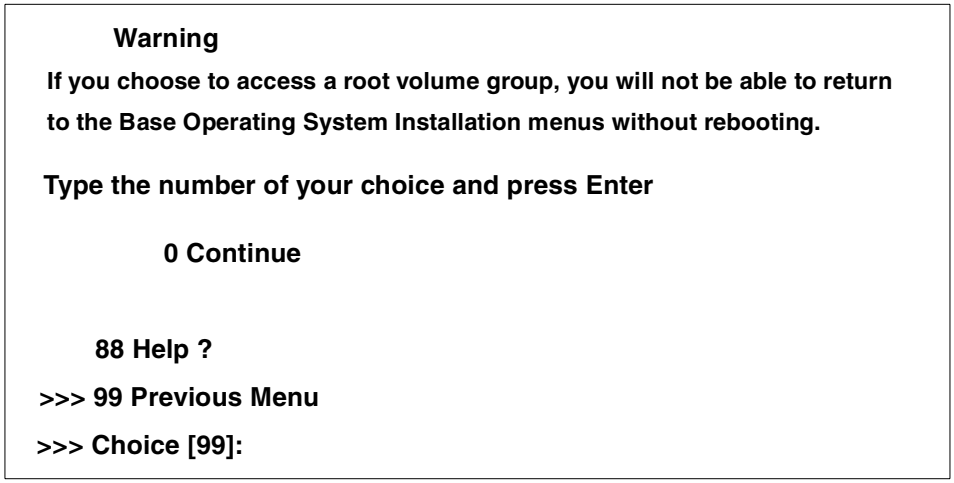

Figure 4. Warning Message Window

7. Enter a **0** and press **Enter**. A screen similar to Figure 5 is shown.

```
                    Access a Root Volume Group

Type the number for a volume group to display logical volume
information and press Enter.

1)      Volume Group 00615147b27f2b40 contains these disks:
           hdisk0 958 04-B0-00-2,0
2)      Volume Group 00615247b27c2b41 contains these disks:
           hdisk1 2063 04-B0-00-6,0


Choice:
```

Figure 5. Accessing a Volume Group

8. Select the volume group whose logical volume information you want to display. This is important since rootvg will contain **hd5** (the boot logical volume). Enter the number of the volume group and press **Enter**. A screen similar to Figure 6 is shown.

```
                    Volume Group Information

Volume Group ID 00615147b27f2b40 includes following logical volumes:

   hd5         hd6         hd8         hd4         hd2         hd9var

   hd3         hd1         lv00        lv01

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 file systems


   99) Previous Menu

      Choice [99]:
```

Figure 6. Volume Group Information

9. Select one of the options from the Volume Group Information screen and press **Enter**. Each option does the following:

   Choice 1 Access this volume group and start a shell.

   Selecting this choice imports and activates the volume group and mounts the file systems for this root volume group before providing you with a shell and a system prompt.

   Choice 2 Access this volume group and start a shell before mounting file systems.

   Selecting this choice imports and activates the volume group and provides you with a shell and system prompt before mounting the file systems for this root volume group.

   Choice 99 Entering **99** returns you to the Access a Root Volume Group screen.

   After either choice 1 or 2 is selected and processed, a shell is started and a system prompt is displayed.

10. Take the appropriate measures to recover data or take additional action (such as using the `bosboot` command) to enable the system to boot normally.

2.5.2 Common Boot Time LED Error Codes and Recovery Actions

The most common boot problems and how to get your system up and running again are given in Table 8.

Table 8. Common Startup LEDs and Recovery Actions

LED 201 - Damaged Boot Image
1. Access your rootvg following the procedure described in 2.5.1, “Accessing a System that Will Not Boot” on page 26.
2. Check the / and /tmp filesystems. If they are almost full, create more space.
3. Determine the boot disk by using the command: `lslv -m hd5`
4. Re-create boot image using: `bosboot -a -d /dev/hdiskn`
5. Check for CHECKSTOP errors in the error log. If such errors are found, it is probably failing hardware.
6. Shutdown and restart the system.

LED 223-229 - Invalid Boot List

1. Set the key mode switch to service (F5 for systems without a keylock) and power up the machine.
2. If display continues normally, change the key mode switch to Normal and continue with step 3. If you do not get the prompt, go to step 4.
3. When you get the login prompt, log in and follow the procedure described in 2.4.4, “Using the bootlist Command” on page 19 to change your bootlist. Continue with step 7.
4. Follow the procedure in 2.5.1, “Accessing a System that Will Not Boot” on page 26 to access your rootvg and continue with step 5.
5. Determine the boot disk by using the command: `lslv -m hd5`
6. Change the bootlist following the procedure given in 2.4.4, “Using the bootlist Command” on page 19.
7. Shutdown and restart your system.

LED 551, 555, and 557 - Errors Including Corrupted File System and Corrupted JFS Log

1. Follow the procedure described in 2.5.1, “Accessing a System that Will Not Boot” on page 26, to access the rootvg before mounting any file systems (Option 2 on the Maintenance screen).
2. Verify and correct the file systems as follows:

   ```
   fsck -y /dev/hd1
   fsck -y /dev/hd2
   fsck -y /dev/hd3
   fsck -y /dev/hd4
   fsck -y /dev/hd9var
   ```

3. Format the JFS log again by using the command:

   ```
   /usr/sbin/logform /dev/hd8
   ```

4. Use `lslv -m hd5` to find out the boot disk.
5. Recreate boot image by using the command:

   ```
   bosboot -a -d /dev/hdiskn
   ```

   Where `n` is the disk number of the disk containing the boot logical volume .

LED 552, 554, and 556 - Super Block Corrupted or Corrupted Customized ODM Database

1. Repeat steps 1 through 2 for LEDs 551, 555, and 557.
2. If `fsck` indicates that block 8 is corrupted, the super block for the file system is corrupted and needs to be repaired. Enter the command:

   ```
   dd count=1 bs=4k skip=31 seek=1 if=/dev/hdn of=/dev/hdn
   ```

   where `n` is the number of the file system.
3. Rebuild your JFS log by using the command:

   ```
   /usr/sbin/logform /dev/hd8
   ```
4. If this solves the problem, stop here; otherwise, continue with step 5.
5. Your ODM database is corrupted. Restart your system and follow the procedure given in 2.5.1, “Accessing a System that Will Not Boot” on page 26 to access rootvg with Choice 2.
6. Mount the root and usr file system as follows:

   ```
   mount /dev/hd4 /mnt
   mount /usr
   ```
7. Copy system configuration to a backup directory:

   ```
   mkdir /mnt/etc/objrepos/backup
   cp /mnt/etc/objrepos/Cu* /mnt/etc/objrepos/backup
   ```
8. Copy configuration from RAM file system as follows:

   ```
   cp /etc/objrepos/Cu* /mnt/etc/objrepos
   ```
9. Unmount all file systems by using the `umount all` command.
10. Determine boot disk by using the `lslv -m hd5` command.
11. Save the clean ODM to the boot logical volume by using the command:

    ```
    savebase -d/dev/hdiskn
    ```
12. Reboot. If system does not come up, reinstall BOS.

LED 553 - Corrupted /etc/inittab file

1. Access the rootvg with all file systems mounted by following the procedure described in 2.5.1, “Accessing a System that Will Not Boot” on page 26.
2. Check for free space in /, /var, and /tmp by using the `df` command.
3. Check the /etc/inittab file and correct the inittab problems, such as an empty inittab file, a missing inittab file, or a wrong entry in the inittab file.
4. Check for execution problems with:
`/etc/environment`
`/bin/sh`
`/bin/bsh`
`/etc/fsck`
`/etc/profile`
`/.profile`
5. Shutdown the system and reboot.

2.6 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. A system administrator suspects that a colleague rebooted their server the previous evening. Which of the following commands will confirm this suspicion?
   A. `uptime`
   B. `lastboot`
   C. `reboot -l`
   D. `bootinfo -t`
2. Once the machine has been powered on, which of the following is the correct way to reach the Systems Management Services menu on a PCI machine?
   A. Press the space-bar when the LED displays 262.
   B. Turn the key to Service mode when the LED displays 200.
   C. Choose SMS when the boot option menu appears on screen.

D. Press the appropriate function key once the keyboard has been enabled.

3. While attempting a preservation install, all of the hardware connections appear to be correct. However, when trying to boot from CD-ROM, the machine ends up in diagnostics. Which of the following is the most likely cause of this problem?

   A. The battery on the machine is bad.

   B. The root volume group is corrupt.

   C. The low-level debugger is not enabled.

   D. There is a hardware problem with the CD-ROM.

2.6.1 Answers

The following are the answers for the previous questions:

1. A
2. D
3. D

2.7 Exercises

Provided here are some exercises you may wish to perform:

1. Change your bootlist to boot over the network over your Token Ring adapter on the next system boot up.
2. Use the `alog` command to find out what events took place during your startup process.
3. Shutdown and restart your system using the `shutdown` command.
4. You have just powered on an external tape drive. Use `cfgmgr` to bring that tape drive into an available state and ensure that you see all the messages with the `cfgmgr` command.
5. Add an application to your shutdown process that gracefully brings down your running databases.
6. Find out the amount of time your system has been online.
7. Find out when root last logged onto the system and from which terminal.
8. Use the `mpcfg` command to change your Fast IPL flag to `true`.

Chapter 3. Hardware Assistance

This chapter discusses various methods to determine the devices installed on your system, the methods available to you to record the system error messages, and then ways of using these messages to solve system problems. It also discusses using the system log to record any desired messages.

3.1 Listing Hardware Devices

In order to learn about the hardware characteristics of your system, you can use the following commands:

`lsdev` Displays devices in the system and their characteristics.

`lspv` Displays information about a physical volume within a volume group.

`lsattr` Displays information about the attributes of a given device or kind of device.

For example, if you need to list all the tapes on your system, use the `lsdev -C -c tape` command. If you want to list the disks on your system, use the `lsdev -C -c disk` command.

3.1.1 Using the lsdev Command

You can use the `lsdev` command to display information about devices in the device configuration database. You can use this command to display information from either the Customized Devices object class in ODM using the -C flag or the Predefined Devices object class in ODM using the -P flag.

The general command syntax of the `lsdev` command is as follows:

```
lsdev -C [ -c Class ] [ -s Subclass ] [ -t Type ] [ -f File ] [ -F
Format | -r ColumnName ] [ -h ] [ -H ] [ -l Name ] [ -S State ]
lsdev -P [-c Class ] [ -s Subclass ] [ -t Type ] [ -f File ] [ -F
Format | -r ColumnName ] [ -h ] [ -H ]
```

Some of the most commonly used flags with the `lsdev` command are given in Table 9.

Table 9. lsdev Command Flags

Flag	Description
-C	Lists information about a device that is in the Customized Devices object class. The default information displayed is name, status, location, and description. This flag cannot be used with the -P flag.
-c *Class*	Specifies a device class name. This flag can be used to restrict output to devices in a specified class.
-H	Displays headers above the column output.
-h	Displays the command usage message.
-P	Lists information about a device that is in the Predefined Devices object class. The default information displayed is class, type, subclass, description. This flag cannot be used with the -C, -l, or -S flags.
-S *State*	Lists all devices in a specified state as named by the State parameter.

Following are some examples of using `lsdev` command to list different device information about a system.

3.1.1.1 Listing Devices in the Predefined ODM Database

To list all devices in the Predefined Devices object class with column headers, on the command line enter:

```
lsdev -P -H
```

The system displays an output similar to Figure 7.

```
class          type            subclass   description

logical_volume vgtype          vgsubclass Volume group
logical_volume lvtype          lvsubclass Logical volume
lvm            lvdd            lvm        LVM Device Driver
aio            aio             node       Asynchronous I/O
pty            pty             pty        Asynchronous Pseudo-Terminal
memory         L2cache_rspc    sys        L2 Cache
memory         totmem          sys        Memory
planar         sysplanar_rspc  sys        System Planar
processor      proc_rspc       sys        Processor
sys            chrp            node       System Object
bus            pci             sys        PCI Bus
tape           1200mb-c        scsi       1.2 GB 1/4-Inch Tape Drive
tape           150mb           scsi       150 MB 1/4-Inch Tape Drive
tape           3490e           scsi       3490E Autoloading Tape Drive
tape           4mm2gb          scsi       2.0 GB 4mm Tape Drive
tape           4mm4gb          scsi       4.0 GB 4mm Tape Drive
tape           525mb           scsi       525 MB 1/4-Inch Tape Drive
tape           8mm             scsi       2.3 GB 8mm Tape Drive
tape           8mm5gb          scsi       5.0 GB 8mm Tape Drive
tape           8mm7gb          scsi       7.0 GB 8mm Tape Drive
tape           9trk            scsi       1/2-inch 9-Track Tape Drive
:
```

Figure 7. Listing Devices from a Pre-Defined ODM Database

3.1.1.2 Listing Devices in Customized ODM Database

To list all the devices in the Customized Devices object class, enter:

```
lsdev -C -H
```

An output similar to Figure 8 is shown:

```
$ lsdev -C -H | pg
name       status    location     description

sys0       Available 00-00        System Object
sysplanar0 Available 00-00        System Planar
bus0       Available 00-00        PCI Bus
bus1       Available 04-A0        ISA Bus
pmc0       Available 01-A0        Power Management Controller
fda0       Available 01-C0        Standard I/O Diskette Adapter
ide0       Available 01-E0        ATA/IDE Controller Device
ide1       Available 01-F0        ATA/IDE Controller Device
sa0        Available 01-G0        Standard I/O Serial Port 1
sa1        Available 01-H0        Standard I/O Serial Port 2
sioka0     Available 01-I0        Keyboard Adapter
sioma0     Available 01-J0        Mouse Adapter
iga0       Available 04-C0        E15 Graphics Adapter
scsi0      Available 04-B0        Standard SCSI I/O Controller
gga0       Available 04-01        IBM Personal Computer Power Series S15 Graphic
s Adapter
rmt0       Available 04-B0-00-0,0 4.0 GB 4mm Tape Drive
cd0        Available 04-B0-00-3,0 SCSI Multimedia CD-ROM Drive
hdisk0     Available 04-B0-00-5,0 SCSI Disk Drive
hdisk1     Available 04-B0-00-6,0 1.0 GB SCSI Disk Drive
mem0       Available 00-00        Memory
:
```

Figure 8. Listing Devices in the Customized ODM Database

3.1.1.3 Listing Available Devices

To list the adapters that are in the Available state in the Customized Devices object class, on the command line enter:

```
lsdev -C -c adapter -S a
```

An output similar to Figure 9 is shown:

```
sa0     Available 01-S1    Standard I/O Serial Port
sa1     Available 01-S2    Standard I/O Serial Port
siokma0 Available 01-K1    Keyboard/Mouse Adapter
fda0    Available 01-D1    Standard I/O Diskette Adapter
scsi0   Available 20-60    Wide SCSI I/O Controller
scsi1   Available 40-58    Wide SCSI I/O Controller
sioka0  Available 01-K1-00 Keyboard Adapter
ppa0    Available 01-R1    Standard I/O Parallel Port Adapter
ssa0    Available 20-68    IBM SSA Enhanced RAID Adapter (14104500)
tok0    Available 40-60    IBM PCI Tokenring Adapter (14101800)
sioma0  Available 01-K1-01 Mouse Adapter
#
```

Figure 9. Listing Available Devices

3.1.1.4 Listing Supported Devices

To list all the classes of supported devices on your system, on the command line enter:

```
lsdev -P -r class
```

An output similar to Figure 10 is shown:

```
adapter
aio
bus
cdrom
container
disk
diskette
dlc
driver
if
logical_volume
lvm
memory
pdisk
planar
printer
processor
pty
pwrmgt
sys
:
```

Figure 10. Listing Supported Devices

3.1.2 Using the lspv Command

The `lsdev` command obtains general information about the devices installed on your system; however, you can find out specific information about your physical volumes using the `lspv` command.

If you do not use command flags with the `lspv` command, the default is to provide every known physical volume in the system along with its physical disk name, physical volume identifiers (PVIDs), and which volume group (if any) it belongs to. If you specify the `lspv` command with a physical volume name, it displays information about that physical volume only. The general syntax of the `lspv` command is as follows:

```
lspv [ -l | -p | -M ] [ -n DescriptorPhysicalVolume]
[-vVolumeGroupID] PhysicalVolume
```

Two of the most commonly used flags with the `lspv` command are given in Table 10.

Table 10. lspv Command Flags

Flag	Description
-p	Lists range, state, region, LV name, type, and mount point for each physical partition on the physical volume.
-v *VolumeGroupID*	Accesses information based on the VolumeGroupID variable.

For example, to display the physical volumes on your system, enter:

```
#lspv
hdisk0          00615147ce54a7ee    rootvg
hdisk1          00615147a877976a    rootvg
```

In order to display the status and characteristics of physical volume `hdisk0`, use the `lspv` command as follows:

```
lspv hdisk0
```

An output similar to Figure 11 is shown:

```
PHYSICAL VOLUME:    hdisk0                  VOLUME GROUP:     rootvg
PV IDENTIFIER:      000919746edab91f        VG IDENTIFIER     000919742b739e57
PV STATE:           active
STALE PARTITIONS:   0                       ALLOCATABLE:      yes
PP SIZE:            8 megabyte(s)           LOGICAL VOLUMES:  8
TOTAL PPs:          537 (4296 megabytes)    VG DESCRIPTORS:   2
FREE PPs:           155 (1240 megabytes)
USED PPs:           382 (3056 megabytes)
FREE DISTRIBUTION:  47..00..00..00..108
USED DISTRIBUTION:  61..107..107..107..00
# 
```

Figure 11. Listing Physical Volume Characteristics

In order to list the status and characteristics of physical volume `hdisk0` by physical partition number, use the `lspv` command as follows:

```
lspv -p hdisk0
```

A screen similar to Figure 12 is shown:

```
hdisk0:
PP RANGE  STATE   REGION        LV NAME             TYPE       MOUNT POINT
  1-1     used    outer edge    hd5                 boot       N/A
  2-48    free    outer edge
 49-51    used    outer edge    hd9var              jfs        /var
 52-52    used    outer edge    hd2                 jfs        /usr
 53-108   used    outer edge    hd6                 paging     N/A
109-116   used    outer middle  hd6                 paging     N/A
117-215   used    outer middle  hd2                 jfs        /usr
216-216   used    center        hd8                 jfslog     N/A
217-217   used    center        hd4                 jfs        /
218-222   used    center        hd2                 jfs        /usr
223-223   used    center        hd9var              jfs        /var
224-225   used    center        hd3                 jfs        /tmp
226-226   used    center        hd1                 jfs        /home
227-322   used    center        hd2                 jfs        /usr
323-409   used    inner middle  hd2                 jfs        /usr
410-411   used    inner middle  hd4                 jfs        /
412-429   used    inner middle  hd2                 jfs        /usr
430-537   free    inner edge
# 
```

Figure 12. Listing Physical Volume Characteristics by Physical Partitions

3.2 Configuring System Devices

When you add a new device to your system, or you need to configure devices that were not detected as available during the boot process, the system must have a way of configuring these devices. The `cfgmgr` command is used to configure devices and, optionally, install device software into the system. The devices to be configured are controlled by the Configuration Rules object class, which is part of the Device Configuration database. Each configuration rule specifies three items:

- The full path name of an executable program to run.
- When to run the program (in relation to the other rules).
- In which phase to run the program.

During system boot, the `cfgmgr` command configures all the devices that are necessary to use the system.

The `cfgmgr` command recognizes three phases of configuration rules:

- Phase 1
- Phase 2 (second boot phase for normal boot)
- Phase 3 (second boot phase for service boot)

During Phase 1, the cfgmgr command is invoked specifying this as Phase 1 by using the -f flag. The cfgmgr command runs all of the Phase 1 configuration rules, which results in the base devices being configured. After this, Phase 2 execution begins, and the cfgmgr command is called with the -s flag.

Normally, the cfgmgr command runs all the rules for the phase specified during invocation (Phase 1 rules for the -f flag). However, if the -l flag is used, the cfgmgr command configures only the named device and its children.

If the cfgmgr command is invoked without a phase option (for example, without the -f,-s, or -p flags), then the command runs the Phase 2 rules. The only way to run the Phase 3 rules is with the -p flag.

The configuration rules for each phase are ordered based on the values specified in the seq field. This field is an integer that specifies the priority in which to execute this rule relative to the other rules for this phase. The higher the number specified by the seq field, the lower the priority; for example, a value of 1 specified in the seq field is run before a rule with a value of 10. There is one exception: A seq field value of 0 implies a *don't care* condition, and any seq field value of 0 is executed last.

Therefore, a seq field value of 1 is the highest priority (first to run).

If there are any devices detected that have no device software installed when configuring devices, the cfgmgr command returns a warning message with the name or a list of possible names for the device package that must be installed. If the specific name of the device package is determined, it is displayed as the only package name on a line below the warning message. If the specific name cannot be determined, a colon-separated list of possible package names is displayed on a single line. A package name or list of possible package names is displayed for each of the devices if more than one device is detected without its device software.

An example is as follows:

```
cfgmgr: 0514-621 WARNING: The following device packages are
        required for device support but are not currently
        installed.
devices.pci.22100020
devices.pci.14101800
devices.pci.scsi:devices.pci.00100300:devices.pci.NCR.53C825
```

In this example, two devices were found whose software is missing, and the cfgmgr command displayed the names of the device packages that must be

installed. A third device whose software is missing was also found but in this case, the `cfgmgr` command displays several possible device package names.

When more than one possible package name is identified for a device, typically only one of the names will actually correspond to a device package on the installation medium. This is the package to install. However, in some cases, more than one of the names will correspond to actual device packages on the installation medium. In this case, the first package name in the list, for which there is an actual device package on the installation medium, is the package that must be installed. If the `cfgmgr` command is used with the -i flag, then the correct packages will be installed.

If you invoke the `cfgmgr` command with the -i flag, the command attempts to install device software automatically for each newly detected device. The device variable of the -i flag specifies where to find the installation medium. The installation medium can be a hardware device (such as a tape or diskette drive), a directory that contains installation images, or the installation image file itself. Some of the common flags used with the `cfgmgr` command are provided in Table 11.

Table 11. cfgmgr Command Flags

Flag	Description
-i *Device*	Specifies the location of the installation medium.
-l *Name*	Instructs the named device to be configured along with its children.
-p *Phase*	Instructs the `cfgmgr` command to run the specified phase.
-s	Instructs the `cfgmgr` command to run the Phase 2 configuration rules.
-v	Specifies the type of details to be written to stdout.

The configuration rules used by the `cfgmgr` command are provided in Table 12.

Table 12. cfgmgr Configuration Rules

Rule	Description
phase	Specifies whether this rule belongs to Phase 1, Phase 2, or Phase 3 (second boot phase for the service mode).
seq	Specifies as an integer, the relative priority of this rule.
rule	A string containing the full path name of a program to run (can also contain any flags, but they must follow the program name, as this whole string is run as if it were typed in on the command line).

The following examples are based on the configuration rules containing the following information:

```
phase    seq        rule

  1      1        /usr/lib/methods/defsys
  1      10       /usr/lib/methods/deflvm
  2      1        /usr/lib/methods/defsys
  2      5        /usr/lib/methods/ptynode
  2      10       /usr/lib/methods/startlft
  2      15       /usr/lib/methods/starttty
  3      1        /usr/lib/methods/defsys
  3      5        /usr/lib/methods/ptynode
  3      10       /usr/lib/methods/startlft
  3      15       /usr/lib/methods/starttty
```

When the `cfgmgr` command is invoked with the `-f` flag, the command gets all of the configuration rules with phase = 1 and runs them in the following order:

```
/usr/lib/methods/defsys
/usr/lib/methods/deflvm
```

Note

The -f flag cannot be used once the system has booted.

When the `cfgmgr` command is run with the -s flag, the command gets all of the configuration rules with phase = 2 and runs them in the following order:

```
/usr/lib/methods/defsys
/usr/lib/methods/ptynode
/usr/lib/methods/startlft
/usr/lib/methods/starttty
```

When the `cfgmgr` command is run with the -p 3 flag, the command gets all of the configuration rules with phase = 3 and runs them in the following order:

```
/usr/lib/methods/defsys
/usr/lib/methods/ptynode
/usr/lib/methods/startlft
/usr/lib/methods/starttty
```

If the `cfgmgr` command is run without a flag, the command functions the same as when used with the -s flag. In order to configure detected devices attached to the SCSI0 adapter, use the `cfgmgr` command as follows:

```
cfgmgr -l scsi0
```

In order to install device software automatically during configuration (with the software contained in a directory), use the `cfgmgr` command as follows:

```
cfgmgr -i /usr/sys/inst.images
```

3.3 System Management Services

The `cfgmgr` command configures devices at the software level. You can use the System Management Services (SMS) to check and configure the system at a hardware level. With SMS, you can check to see if all available hardware has been detected, or you can test certain hardware for failure.

In order to access the SMS utility, use the following instructions:

1. Begin with your machine turned off.
2. If your system requires an SMS diskette, insert it into the diskette drive of the client and turn on the machine. If you do not insert an SMS diskette at this time, and one is required, you will be prompted to insert one later.
3. As icons begin to display from left to right on the bottom of your display, press the **F1** key for the Graphical SMS menu or the **F4** key for an ASCII SMS menu.

> **Note**
>
> If the last icon is displayed prior to pressing the **F1** or **F4** key, the normal mode boot list is used instead of the System Management Services diskette.

4. The SMS menu is displayed on your screen. You can do your hardware testing or configuration as needed.

You can change the advisory password in the SMS menu so that only authorized people can access the SMS utility. If you forget this password, the only way to recover from this is to remove the on-board system battery.

3.4 Hardware Device Compatibility

RSPC and RS/6000 Platform Architecture (RPA) systems may support attachment of devices using the following buses:

- PCI
- ISA
- SCSI

Provided the device support software is installed, PCI and SCSI devices are configured automatically whenever the Configuration Manager program (`cfgmgr`) is run at system boot and when no conflict (for example, the same SCSI ID for two SCSI devices) is found.

Non-native ISA devices will have to be configured manually, and you may even need to change some of the device's predefined or customized attribute values especially when configuring two or more ISA devices of the same type.

Even though you can have multiple adapters on one system, you may not always be able to run different devices on the same adapter. There are various different configurations according to the specification of your particular machine. For example, if you have a SCSI Single-Ended (SE) Ultra Controller, only SE SCSI devices can connect to it, not differential devices. Likewise, If you have a 100 Mbps Ethernet LAN, a 10 Mbps Ethernet card will not work.

3.4.1 Device Configuration Database

Device information is contained in a predefined database or a customized database that makes up the Device Configuration Database managed by the Object Data Manager (ODM).

- The predefined database contains configuration data for all possible devices configured to the system.
- The customized database contains configuration data for all currently defined and configured devices in the system.

The device information stored in the Device Configuration Database allows the automatic configuration of microchannel devices on RISC System/6000 systems and PCI devices on RSPC and RPA (non Micro Channel) systems whenever the Configuration Manager (`cfgmgr`) program is run at system boot and run time.

As for non-native ISA devices, the information data contained in the predefined part of the configuration database is not sufficient to perform automatic, conflict-free, ISA device configuration. Thus, the user needs to manually customize some values to be used by the ISA device (for example, interrupt level, shared memory address, and so forth) when configuring the device for the first time.

3.5 Using the lsattr Command

After configuring all the devices in the system, you can use the `lsattr` command to display information about the attributes of a given device or kind of device. If you do not specify the device's logical name (`-l` *Name*), you must use a combination of one or all of the -c *Class*, -s *Subclass*, and -t *Type* flags to uniquely identify the predefined device. The general syntax of the `lsattr` command is as follows:

```
lsattr { -D [ -O ] | -E [ -O ] | -F Format } -l Name [ -a Attribute ] ...[
-f File ] [ -h ] [ -H ]
lsattr { -D [ -O ] | -F Format } { [ -c Class ] [ -s Subclass ] [ -t Type ]
} [ -a Attribute ] ... [ -f File ] [ -h ] [ -H ]
lsattr -R { -l Name | [ -c Class ] [ -s Subclass ] [ -t Type ] } -a
Attribute [ -f File ] [ -h ] [ -H ]
```

The flags commonly used with the `lsattr` command are given in Table 13.

Table 13. lsattr Command Flags

Flag	Description
-D	Displays the attribute names, default values, descriptions, and user-settable flag values for a specific device when not used with the -O flag. The -D flag displays only the attribute name and default value in colon format when used with the -O flag.
-E	Displays the attribute names, current values, descriptions, and user-settable flag values for a specific device when not used with the -O flag. The -E flag only displays the attribute name and current value in colon format when used with the -O flag. This flag cannot be used with the -c, -D, -F, -R, -s, or -t flags.
-F *Format*	Displays the output in a user-specified format.
-a *Attribute*	Displays information for the specified attributes of a specific device or kind of device.
-c *Class*	Specifies a device class name. This flag cannot be used with the -E or -l flags.
-f *File*	Reads the needed flags from the File parameter.
-H	Displays headers above the column output. To use the -H flag with either the -O or the -R flags is meaningless; the -O or -R flag prevails.
-l *Name*	Specifies the device logical name in the Customized Devices object class whose attribute names or values are to be displayed.
-O	Displays all attribute names separated by colons and, on the second line, displays all the corresponding attribute values separated by colons.

Flag	Description
-R	Displays the legal values for an attribute name. The -R flag cannot be used with the -D, -E, -F and -O flags, but can be used with any combination of the -c, -s, and -t flags that uniquely identifies a device from the Predefined Devices object class or with the -l flag. The -R flag displays the list attribute values in a vertical column as follows: Value1 Value2 . . ValueN The -R flag displays the range attribute values as x...n(+i) where x is the start of the range, n is the end of the range, and i is the increment.
-s *Subclass*	Specifies a device subclass name. This flag can be used to restrict the output to that of devices for a specified subclass. This flag cannot be used with the -E or -l flags.
-t *Type*	Specifies a device type name. This flag can be used to restrict the output to that of devices of a specified class. This flag cannot be used with the -E or -l flag.

When displaying the effective values of the attributes for a customized device, the information is obtained from the Configuration database, not the device. Generally, the database values reflect how the device is configured unless it is reconfigured with the `chdev` command using the -P or -T flag. If this has occurred, the information displayed by the `lsattr` command might not correctly indicate the current device configuration until after the next system boot.

If you use the -D or -E flags, the output defaults to the values for the attribute's name, value, description, and user-settable strings unless also used with the -O flag. The -O flag displays the names of all attributes specified separated by colons. On the next line, the -O flag displays all the corresponding attribute values separated by colons. The -H flag can be used with either the -D, -E, or -F flags to display headers above the column names. You can define the format of the output with a user-specified format where the format parameter is a quoted list of column names separated by non-alphanumeric characters or white space using the -F *Format* flag.

You can supply the flags either on the command line or from the specified file parameter. The following are some examples on the usage of the `lsattr` command.

- In order to list the current attribute values for the tape device `rmt0`, use the `lsattr` command as follows:

```
# lsattr -l rmt0 -E
mode       yes  Use DEVICE BUFFERS during writes     True
block_size 1024 BLOCK size (0=variable length)       True
extfm      no   Use EXTENDED file marks              True
ret_error  no   RETURN error on tape change or reset True
```

- In order to list the default attribute values for the tape device `rmt0`, use the `lsattr` command as follows:

```
# lsattr -l rmt0 -D
mode       yes  Use DEVICE BUFFERS during writes     True
block_size 1024 BLOCK size (0=variable length)       True
extfm      no   Use EXTENDED file marks              True
ret_error  no   RETURN error on tape change or reset True
```

- In order to list the current value of the `bus_intr_lvl` attribute for the SCSI adapter `scsi0`, use the `lsattr` command as follows:

```
# lsattr -l scsi0 -a bus_intr_lvl -E
bus_intr_lvl 14 Bus interrupt level False
```

- In order to list the possible values of the login attribute for the tty device `tty0`, use the `lsattr` command as follows:

```
# lsattr -l tty0 -a login -R
enable
disable
share
delay
hold
```

  Depending on your software configuration, you may see a different command response than the previous one. Try the command with a different device and attribute and learn how it behaves.

3.6 The System Error Log

Once you have all the devices configured in your system and your system is in production, you may encounter errors related to hardware during your normal day-to-day operations. AIX provides the error logging facility for recording hardware and software failures in an error log. This error log can be used for information purposes or for fault detection and corrective actions.

The error logging process begins when an operating system module detects an error. The error-detecting segment of code then sends error information to

either the errsave and errlast kernel service or the errlog application subroutine where the information is, in turn, written to the /dev/error special file. This process then adds a time stamp to the collected data. You can use the `errpt` command to retrieve an error record from the error log.

3.6.1 Using the errdemon Command

The errdemon process constantly checks the /dev/error file for new entries. When new data matches an item in the Error Record Template Repository, the daemon collects additional information from other system components.

The `errdemon` command is normally started automatically during system start-up, however, if it has been terminated for any reason and you need to restart it, enter:

```
/usr/lib/errdemon
```

In order to determine the path to your system's error log file, run the following command:

```
# /usr/lib/errdemon -l
Error Log Attributes
-------------------------------------------
Log File                /var/adm/ras/errlog
Log Size                1048576 bytes
Memory Buffer Size      8192 bytes
```

In order to change the maximum size of the error log file, enter:

```
/usr/lib/errdemon -s 2000000
```

In order to change the size of the error log device driver's internal buffer, enter:

```
/usr/lib/errdemon -B 16384
```

A message similar to the following is displayed:

```
0315-175 The error log memory buffer size you supplied will be rounded up
to a multiple of 4096 bytes.
```

3.6.2 Using the errpt Command

In order to retrieve the entries in the error log, you can use the `errpt` command. The `errpt` command generates an error report from entries in an error log. It includes flags for selecting errors that match specific criteria. By using the default condition, you can display error log entries in the reverse order in which they occurred and were recorded.

Note

The `errpt` command does not perform error log analysis; for analysis, use the `diag` command.

The general syntax of the `errpt` command is as follows:

```
errpt [ -a ] [ -c ] [ -d ErrorClassList ] [ -e EndDate ] [ -g ] [ -i File ]
[ -j ErrorID [ ,ErrorID ] ] | [ -k ErrorID [ ,ErrorID ]] [ -J ErrorLabel [
,ErrorLabel ] ] | [ -K ErrorLabel [ ,ErrorLabel ] ] [ -l SequenceNumber ] [
-m Machine ] [ -n Node ] [-s StartDate ] [ -F FlagList ] [ -N
ResourceNameList ] [ -R ResourceTypeList ] [ -S ResourceClassList ] [ -T
ErrorTypeList ] [ -y File ] [ -z File ]
```

Some of the most commonly used flags used with the `errpt` command are given in Table 14.

Table 14. errpt Command Flags

Flag	Description
-a	Displays information about errors in the error log file in a detailed format. If used in conjunction with the - t flag, all the information from the template file is displayed.
-j *ErrorID[,ErrorID]*	Includes only the error-log entries specified by the ErrorID (error identifier) variable. The ErrorID variables can be separated by commas (,) or enclosed in double quotation marks ("") and separated by commas (,) or space characters. When combined with the -t flag, entries are processed from the error-template repository.
-s *StartDate*	Specifies all records posted after the StartDate variable, where the StartDate variable has the form *mmddhhmmyy* (month, day, hour, minute, and year).
-t	Processes the error-record template repository instead of the error log. The -t flag can be used to view error-record templates in report form.
-F *FlagList*	Selects error-record templates according to the value of the Alert, Log, or Report field of the template.
-J *ErrorLabel*	Includes the error log entries specified by the ErrorLabel variable.

The following sections show a few examples of using the `errpt` command.

3.6.2.1 Displaying Errors Summary

To display a complete summary report of the errors that have been encountered so far, on the command line, use the `errpt` command as follows:

```
# errpt
IDENTIFIER TIMESTAMP  T C RESOURCE_NAME  DESCRIPTION
2BFA76F6   1025181998 T S SYSPROC        SYSTEM SHUTDOWN BY USER
9DBCFDEE   1025182198 T O errdemon       ERROR LOGGING TURNED ON
2BFA76F6   1025175998 T S SYSPROC        SYSTEM SHUTDOWN BY USER
9DBCFDEE   1025180298 T O errdemon       ERROR LOGGING TURNED ON
2BFA76F6   1025174098 T S SYSPROC        SYSTEM SHUTDOWN BY USER
9DBCFDEE   1025174398 T O errdemon       ERROR LOGGING TURNED ON
.......... (Lines Removed)
2BFA76F6   1021134298 T S SYSPROC        SYSTEM SHUTDOWN BY USER
9DBCFDEE   1021135098 T O errdemon       ERROR LOGGING TURNED ON
2BFA76F6   1021120198 T S SYSPROC        SYSTEM SHUTDOWN BY USER
9DBCFDEE   1021130298 T O errdemon       ERROR LOGGING TURNED ON
9DBCFDEE   1018210898 T O errdemon       ERROR LOGGING TURNED ON
9DBCFDEE   0808123837 T O errdemon       ERROR LOGGING TURNED ON
9DBCFDEE   0918153137 T O errdemon       ERROR LOGGING TURNED ON
9DBCFDEE   0918145637 T O errdemon       ERROR LOGGING TURNED ON
```

3.6.2.2 Displaying Error Details

To display a detailed report of all the errors encountered on the system, use the `errpt` command as follows:

```
# errpt -a
---------------------------------------------------------------------------
LABEL:          REBOOT_ID
IDENTIFIER:     2BFA76F6

Date/Time:       Sun Oct 25 18:19:04
Sequence Number: 60
Machine Id:      006151474C00
Node Id:         sv1051c
Class:           S
Type:            TEMP
Resource Name:   SYSPROC

Description
SYSTEM SHUTDOWN BY USER

Probable Causes
SYSTEM SHUTDOWN

Detail Data
USER ID
```

```
          0
0=SOFT IPL 1=HALT 2=TIME REBOOT
          0
TIME TO REBOOT (FOR TIMED REBOOT ONLY)
.......... (Lines Removed)
---------------------------------------------------------------------------
LABEL:          DISK_ERR3
IDENTIFIER:     35BFC499

Date/Time:       Thu Oct 22 08:11:12
Sequence Number: 36
Machine Id:      006151474C00
Node Id:         sv1051c
Class:           H
Type:            PERM
Resource Name:   hdisk0
Resource Class:  disk
Resource Type:   scsd
Location:        04-B0-00-6,0
VPD:
        Manufacturer.................IBM
        Machine Type and Model......DORS-32160    !#
FRU Number..................
        ROS Level and ID............57413345
        Serial Number...............5U5W6388
        EC Level....................85G3685
        Part Number.................07H1132
        Device Specific.(Z0)........000002028F00001A
        Device Specific.(Z1)........39H2916
        Device Specific.(Z2)........0933
        Device Specific.(Z3)........1296
        Device Specific.(Z4)........0001
        Device Specific.(Z5)........16

Description
DISK OPERATION ERROR

Probable Causes
DASD DEVICE
STORAGE DEVICE CABLE

Failure Causes
DISK DRIVE
DISK DRIVE ELECTRONICS
STORAGE DEVICE CABLE

        Recommended Actions
```

```
Detail Data
SENSE DATA
0A06 0000 2800 0088 0002 0000 0000 0200 0200 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0001 0001 2FC0
..........  (Lines Removed)
---------------------------------------------------------------------------
LABEL:          ERRLOG_ON
IDENTIFIER:     9DBCFDEE

Date/Time:       Fri Sep 18 14:56:55
Sequence Number: 14
Machine Id:      006151474C00
Node Id:         sv1051c
Class:           O
Type:            TEMP
Resource Name:   errdemon

Description
ERROR LOGGING TURNED ON

Probable Causes
ERRDEMON STARTED AUTOMATICALLY

User Causes
/USR/LIB/ERRDEMON COMMAND

        Recommended Actions
        NONE
```

3.6.2.3 Displaying Errors by Time Reference

If you suspect that the errors were encountered during the last day, you can display a detailed report of all errors logged in the past 24 hours, where the string equals the current month, day, hour, minute, and year, minus 24 hours. To do so, use the `errpt` command as follows:

```
# date
Fri Oct 30 08:24:00 CST 1998
# errpt -a -s 1029082498
---------------------------------------------------------------------------
LABEL:          ERRLOG_ON
IDENTIFIER:     9DBCFDEE
```

```
Date/Time:       Sat Aug  8 12:38:35
Sequence Number: 16
Machine Id:      006151474C00
Node Id:         sv1051c
Class:           O
Type:            TEMP
Resource Name:   errdemon

Description
ERROR LOGGING TURNED ON

Probable Causes
ERRDEMON STARTED AUTOMATICALLY

User Causes
/USR/LIB/ERRDEMON COMMAND

        Recommended Actions
        NONE
.......... (Lines Removed)
---------------------------------------------------------------------------
LABEL:          ERRLOG_ON
IDENTIFIER:     9DBCFDEE

Date/Time:       Fri Sep 18 14:56:55
Sequence Number: 14
Machine Id:      006151474C00
Node Id:         sv1051c
Class:           O
Type:            TEMP
Resource Name:   errdemon

Description
ERROR LOGGING TURNED ON

Probable Causes
ERRDEMON STARTED AUTOMATICALLY

User Causes
/USR/LIB/ERRDEMON COMMAND

        Recommended Actions
        NONE
```

3.6.3 Other Error Handling Commands

In addition to the `errpt` command, the following commands can be used in conjunction with the `errpt` command to find hardware errors and take corrective measures for any problems reported by the error logging facility:

`diag`	Performs hardware problem determination.
`errclear`	Deletes entries from the error log.
`errinstall`	Installs messages in the error logging message sets.
`errupdate`	Updates the Error Record Template Repository.

3.7 The System Log

In order to log system messages, AIX uses syslogd. The syslogd daemon reads a datagram socket and sends each message line to a destination described by the /etc/syslog.conf configuration file. The syslogd daemon reads the configuration file when it is activated and when it receives a hang-up signal.

The syslogd daemon creates the /etc/syslog.pid file, which contains a single line with the command process ID used to end or reconfigure the syslogd daemon.

A terminate signal sent to the syslogd daemon ends the daemon. The syslogd daemon logs the end-signal information and terminates immediately.

Each message is one line. A message can contain a priority code marked by a digit enclosed in < > (angle braces) at the beginning of the line. Messages longer than 900 bytes may be truncated.

The /usr/include/sys/syslog.h include file defines the facility and priority codes used by the configuration file. Locally written applications use the definitions contained in the syslog.h file to log messages using the syslogd daemon.

The general syntax of the `syslogd` command is as follows:

```
syslogd [ -d ] [ -s ] [ -f ConfigurationFile ] [ -m MarkInterval ] [-r]
```

The flags commonly used when starting syslogd are provided in Table 15.

Table 15. syslogd Daemon Flags

Flag	Description
-d	Turns on debugging.

Flag	Description
-f *Config File*	Specifies an alternate configuration file.
-m *MarkInterval*	Specifies the number of minutes between the `mark` command messages. If you do not use this flag, the `mark` command sends a message with LOG_INFO priority sent every 20 minutes. This facility is not enabled by a selector field containing an * (asterisk), which selects all other facilities.
-s	Specifies to forward a shortened message to another system (if it is configured to do so) for all the forwarding syslogd messages generated on the local system.
-r	Suppresses logging of messages received from remote hosts.

The syslogd daemon uses a configuration file to determine where to send a system message depending on the message's priority level and the facility that generated it. By default, syslogd reads the default configuration file /etc/syslog.conf, but if you specify the -f flag, you can specify an alternate configuration file.

3.7.1 The syslogd Configuration File

The /etc/syslog.conf file controls the behavior of the syslogd daemon. For example, syslogd uses /etc/syslog.conf file to determine where to send the error messages or how to react to different system events. The following is a part of the default /etc/syslog.conf file.

```
/etc/syslog.conf - control output of syslogd
#
# Each line must consist of two parts:-
#
# 1) A selector to determine the message priorities to which the
#    line applies
# 2) An action.
#
# The two fields must be separated by one or more tabs or spaces.
#
# format:
#
# <msg_src_list>                <destination>
#
# where <msg_src_list> is a semicolon separated list of
<facility>.<priority>
# where:
#
# <facility> is:
```

```
#       * - all (except mark)
#       mark - time marks
#       kern,user,mail,daemon, auth,... (see syslogd(AIX Commands
Reference))
#
# <priority> is one of (from high to low):
#       emerg/panic,alert,crit,err(or),warn(ing),notice,info,debug
#       (meaning all messages of this priority or higher)
#
# <destination> is:
#       /filename - log to this file
#       username[,username2...] - write to user(s)
#       @hostname - send to syslogd on this machine
#       * - send to all logged in users
#
# example:
# "mail messages, at debug or higher, go to Log file. File must exist."
# "all facilities, at debug and higher, go to console"
# "all facilities, at crit or higher, go to all users"
#  mail.debug           /usr/spool/mqueue/syslog
#  *.debug              /dev/console
#  *.crit                       *
```

In addition to the /etc/syslog.conf file that contains the settings for the syslogd daemon, the /etc/syslog.pid file contains a list of all the process IDs.

3.7.2 The Format of the Configuration File

This section describes what the format is of the /etc/syslog.conf file is and how you can interpret the different entries in this file. Lines in the configuration file for the syslogd daemon contain a selector field and an action field separated by one or more tabs.

The selector field names a facility and a priority level. These are separate facility names with a comma (**,**), separate the facility and priority-level portions of the selector field with a period (**.**), and separate multiple entries in the same selector field with a semicolon (**;**). To select all facilities, use an asterisk (*).

The action field identifies a destination (file, host, or user) to receive the messages. If routed to a remote host, the remote system will handle the message as indicated in its own configuration file. To display messages on a user's terminal, the destination field must contain the name of a valid, logged-in system user.

3.7.2.1 Facilities

Table 16 lists some of the facilities used in the /etc/syslog.conf file. You can use these system facility names in the selector field.

Table 16. Facilities Used in the /etc/syslog.conf File

Facility	Description
kern	Kernel
user	User level
mail	Mail subsystem
daemon	System daemons
auth	Security or authorization
syslog	syslogd daemon
lpr	Line-printer subsystem
news	News subsystem
uucp	uucp subsystem
*	All facilities

3.7.2.2 Priority Levels

Table 17 lists the priority levels used in the /etc/syslog.conf file. You can use the message priority levels in the selector field. Messages of the specified priority level and all levels above it are sent as directed.

Table 17. Priority Levels for the /etc/syslog.conf File

Priority Level	Description
emerg	Specifies emergency messages (LOG_EMERG). These messages are not distributed to all users. LOG_EMERG priority messages can be logged into a separate file for reviewing.
alert	Specifies important messages (LOG_ALERT), such as a serious hardware error. These messages are distributed to all users.
crit	Specifies critical messages not classified as errors (LOG_CRIT), such as improper login attempts. LOG_CRIT and higher-priority messages are sent to the system console.
err	Specifies messages that represent error conditions (LOG_ERR), such as an unsuccessful disk write.

Priority Level	Description
warning	Specifies messages for abnormal, but recoverable, conditions (LOG_WARNING).
notice	Specifies important informational messages (LOG_NOTICE). Messages without a priority designation are mapped into this priority. These are more important than informational messages, but not warnings.
info	Specifies informational messages (LOG_INFO). These messages can be discarded but are useful in analyzing the system.
debug	Specifies debugging messages (LOG_DEBUG). These messages may be discarded.
none	Excludes the selected facility. This priority level is useful only if preceded by an entry with an * (asterisk) in the same selector field.

3.7.2.3 Destinations

Table 18 lists a few of the destinations that are used in the /etc/syslog.conf file. You can use these message destinations in the action field.

Table 18. Destination Description for the /etc/syslog.conf File

Destination	Description
File Name	Full path name of a file opened in append mode.
@Host	Host name, preceded by @ (at sign).
User[, User][...]	User names.
*	All users.

3.7.3 Using the System Log

To customize the /etc/syslog.conf file so that your required conditions are met, the system log should be updated by editing the /etc/syslog.conf file. After you have edited and added your lines to the /etc/syslog.conf file, you need to restart the syslogd daemon. You can do this by running the following commands:

1. Check to see what the syslog daemon process ID is. In this case, it is `5426`.

```
# ps -ef | grep syslogd
root  5426  4168   0   Nov 01      -  0:00 /usr/sbin/syslogd
root 24938 25854   2 12:04:03  pts/6  0:00 grep syslog
```

2. Use the stopsrc command to stop the syslog daemon as follows:

```
# stopsrc -s syslogd
0513-044 The stop of the syslogd Subsystem was completed successfully.
```

3. Check if the syslog daemon has been stopped successfully.

```
# ps -ef | grep syslogd
root 26112 25854   2 12:04:16  pts/6  0:00 grep syslog
```

4. Restart the syslog daemon.

```
# startsrc -s syslogd
0513-059 The syslogd Subsystem has been started. Subsystem PID is 13494.
```

The following are a few examples on the /etc/syslog.conf file usage.

- To log all mail facility messages at the debug level or above to the file /tmp/mailsyslog, enter:

  ```
  mail.debug /tmp/mailsyslog
  ```

  Where:

  - mail is the Facility as per Table 16 on page 59.
  - debug is the Priority Level as per Table 17 on page 59.
  - /tmp/mailsyslog is the Destination as per Table 18 on page 60.

- To send all system messages except those from the mail facility to a host named rigil, enter:

  ```
  *.debug;mail.none @rigil
  ```

  Where:

  - * and mail are the Facilities as per Table 16 on page 59.
  - debug and none are the Priority Levels as per Table 17 on page 59.
  - @rigil is the Destination as per Table 18 on page 60.

- To send messages at the emerg priority level from all facilities and messages at the crit priority level and above from the mail and daemon facilities to users nick and jam, enter:

  ```
  *.emerg;mail,daemon.crit nick, jam
  ```

  Where:

  - *, mail and daemon are the Facilities as per Table 16 on page 59.
  - emerg and crit are the Priority Levels as per Table 17 on page 59.
  - nick and jam are the Destinations as per Table 18 on page 60.

- To send all mail facility messages to all users' terminal screens, enter:

```
mail.debug *
```

Where:

- `mail` is the Facility as per Table 16 on page 59.
- `debug` is the Priority Level as per Table 17 on page 59.
- `*` is the Destination as per Table 18 on page 60.

3.8 Setting Up an ASCII Terminal

The 3151 display can connect directly, or through a modem, to an AIX system. The connection to the AIX system can be made to one of the native serial ports as shown in Figure 13 or to an asynchronous adapter as shown in Figure 14. Additionally, a printer can be connected to the 3151 display and is supported by AIX as Terminal Attached Printing as displayed in Figure 13.

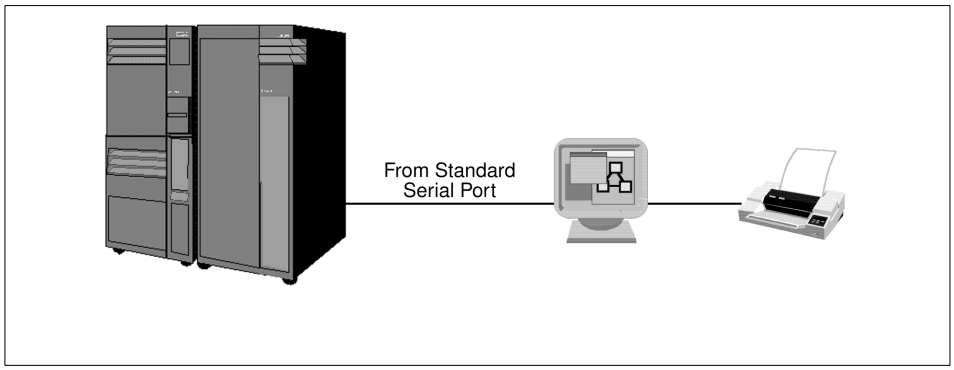

Figure 13. Attaching a Serial Terminal to an RS/6000 System

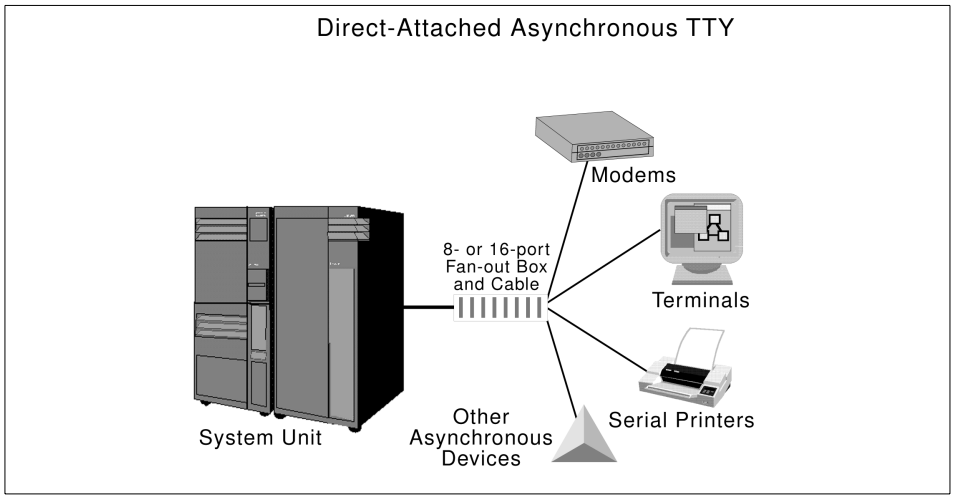

Figure 14. Terminal Connection to Direct-Attached Asynchronous Adapter

In order to add a tty, use the following procedure:

1. Issue `smitty tty` and select **Add a TTY** or `smitty maktty`.
2. The system will ask you for the tty type and the parent adapter. Select the correct values from the list and press **Enter**.

   A screen similar to Figure 15 on page 64 will be shown:

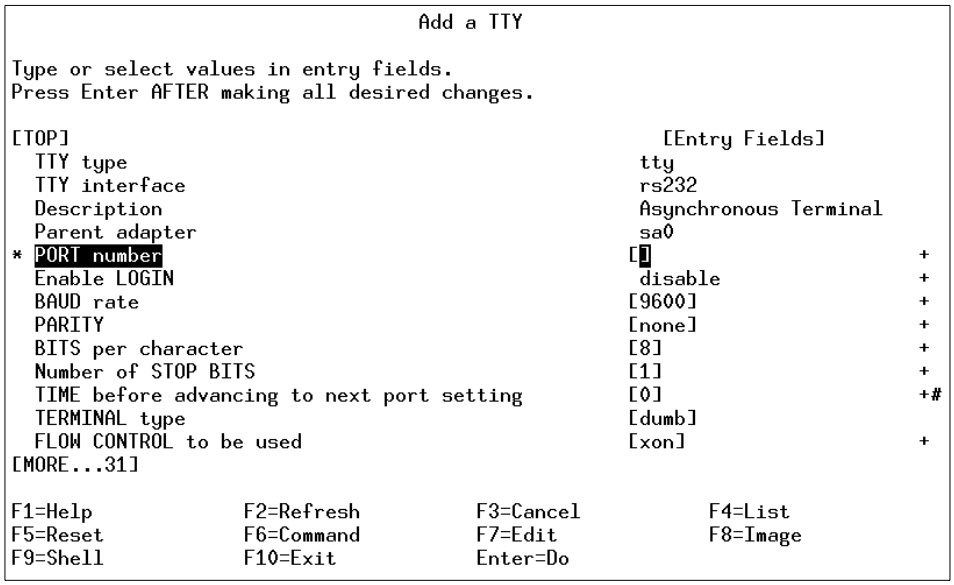

Figure 15. Adding a TTY

3. Select the port number you want this tty to be added to in the PORT number field. For RANs, follow the location code rules to select the appropriate port number.
4. Change the TERMINAL Type field to the type of terminal you are using. This field is very important since you might not be able to use all the keys on your terminal if this field is set incorrectly. The TERM environment variable stores this setting. You can change the terminal emulation setting by using your TERM environment variable and using the `export` command to store the terminal emulation you want to use. For example, in order to use ibm3151 terminal emulation, use the command:

   ```
   TERM=ibm3151; export TERM
   ```

5. Set the line speed and the kind of communication (1/8/N or 1/7/E) for your terminal and press **Enter**.

   This will create a device special file in the /dev directory and add an entry to the /etc/inittab file in order to run the getty process on your terminal so that your terminal is available at system startup. It also adds another entry to the customized ODM (CuDv) database for the terminal you have just added.

You can also add a tty directly on the command line. In order to add an ibm3151 RS232 terminal using adapter sa0 and port s1 with login enabled use the following command:

```
mkdev -c tty -t tty -s rs232 -p sa0 -w s1 -a login=enable -a term=ibm3151
```

You can remove a terminal by using the command:

```
rmdev -l <tty name> -d
```

- Where `<tty name>` can be determined by using the command `tty` or by listing all the ttys and then selecting the tty you want to remove.

On the ASCII terminal, set the communications options as follows:

```
Line Speed (baud rate) = 9600
Word Length (bits per character) = 8
Parity = no (none)
Number of Stop Bits = 1
Interface = RS-232C (or RS-422A)
Line Control = IPRTS
```

Set the keyboard and display options as follows:

```
Screen = normal
Row and Column = 24x80
Scroll = jump
Auto LF (line feed) = off
Line Wrap = on
Forcing Insert = line (or both)
Tab = field
Operating Mode = echo
Turnaround Character = CR
Enter = return
Return = new line
New Line = CR
Send = page
Insert Character = space
```

Note

If your terminal is an IBM 3151, 3161, or 3164, press the **Ctrl+Setup** keys to display the Setup Menu and follow the on-screen instructions to set these fields.

If you are using some other ASCII terminal, refer to the appropriate documents for information about how to set these fields.

3.9 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. The marketing group within the Widget Company plans to implement a new database to house their demographic data. The administrator has requested a tape drive and an additional disk to support the installation of this new database. The IBM hardware engineer has connected the new equipment, and the machine has been rebooted. Which of the following commands should be used to verify the tape device is installed correctly?

   A. `lspv`

   B. `lsdev`

   C. `lstape`

   D. `lsdisk`

2. The marketing group within the Widget Company plans to implement a new database as in question one. The new tape drive appears to be installed and functioning correctly. However, while attempting to perform a `mksysb` utilizing the new drive, it fails. What would be the first recommended action to take to determine the cause of the failure?

   A. Replace the tape drive.

   B. Run `cfgmgr` to reconfigure the tape device.

   C. Check the error log for tape drive errors.

   D. Use SMIT to change the compression attribute on the tape device.

3. A system administrator has just set up an new machine with two external hard disks in a SCSI chain. One is a 2.2 GB SE (single ended) disk, and the other is a 4.5 GB differential disk. The system administrator reboots the machine and notices that only the SE disk is available. Which of the following is the most likely cause?

   A. The SE disk is most likely experiencing hardware problems.

   B. There is most likely a SCSI conflict between the two drives.

   C. The SE and Differential drives are on the same chain.

   D. The Differential disk is most likely experiencing hardware problems.

4. Which of the following commands can be used to determine the serial port settings?

   A. `lscfg -vl ttyXX`

   B. `ls -l /dev/ttyXX`

C. `lsattr -El /ttyXX`

D. `lsdev -C |grep ttyXX`

5. A machine has a bootlist that is set for network booting. In attempting to access SMS menus in order to change the bootlist to the local disk, it is discovered that someone has set an SMS supervisory password, and the password is not recorded. Which of the following actions will allow the system administrator to gain access to the SMS menus?

   A. Boot from AIX installation media, then reinstall SMS.

   B. Boot from AIX installation media, then reset the supervisory password.

   C. Call IBM and ask for the over-ride password based on the serial number.

   D. Remove the battery from the system for at least one minute. Replace the battery and then reboot.

3.9.1 Answers

The following are the answers to the previous questions:

1. B
2. C
3. C
4. C
5. D

3.10 Exercises

Provided here are some exercises you may wish to perform:

1. Check the error log. Are there any problems you should worry about?
2. Check the system log. Determine what information is in the file and add additional information that you want reported on.
3. Configure a new device. Use the cfgmgr command to configure the device.

Chapter 4. System and Software Installation

This chapter describes the installation process, the common commands that are used with the installation process, and the different methods available to you for installing software onto a system. It covers Base Operating System (BOS) installation options, installation of the optional software, and the application of updates to bring your system to the latest maintenance level.

Figure 16 shows a flow chart of the steps for installing a system.

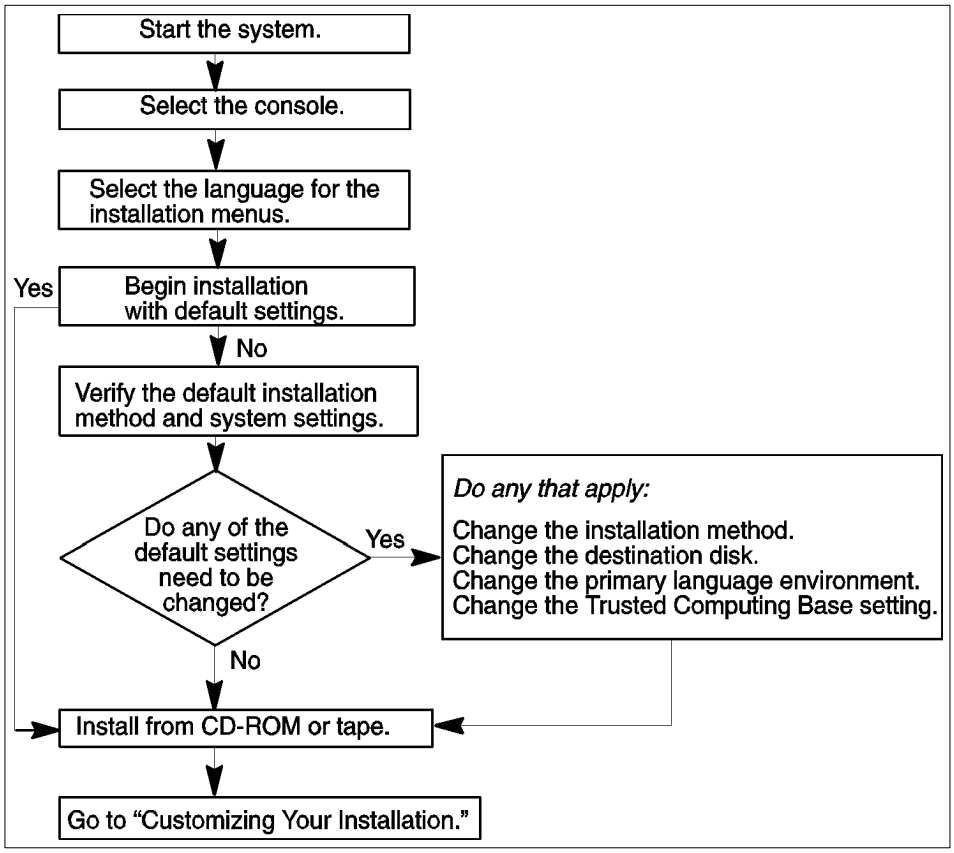

Figure 16. Flow Chart for System Installation

4.1 Base Operating System Installation

In order to install the Base Operating System, you should first boot the system in the maintenance mode. The Welcome to Base Operating System Installation and Maintenance screen is displayed similar to Figure 17.

```
Welcome to Base Operating System
Installation and Maintenance

Type the number of your choice and press Enter.

  1 Start Installation Now with Default Settings

  2 Change/Show Installation Settings and Install

  3 Start Maintenance Mode for System Recovery



 88 Help ?

Choice:
```

Figure 17. BOS Welcome Screen

Select **2** on this screen, and you will be shown a screen similar to Figure 18 on page 70.

```
                        Installation and Settings

      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  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)
        3  Install Trusted Computing Base.....no
>>>  0  Install with the settings listed above.
                                  +-----------------------------------+
     88  Help ?                   | Warning: Base Operating System    |
     99  Previous Menu            | Installation will destroy or      |
                                  | impair recovery of ALL data on the|
>>>  Choice  [0]:                 | destination disk hdisk0.          |
```

Figure 18. Installation Settings

In the Installation and Settings screen, you can set the method of your installation, your language environments, and your preference regarding

installing the Trusted Computing Base. Trusted Computing Base is to provide an extra level of security and ensures that whatever you are trying to run is actually run. If you set this attribute to YES, the install process will install the bos.rte.security fileset, and you can configure TCB. It is important to note that you can enable TCB only at this time. If you decide not to install TCB now, you will have to reinstall the operating system in order to enable TCB at a later stage. TCB can be removed by removing the bos.rte.security fileset from the system.

There are three ways in which you can install AIX on your system. These methods are as follows:

- New and Complete Overwrite Installation
- Migration Installation
- Preservation Installation

4.1.1 New and Complete Overwrite Installation

Generally, the New and Complete Overwrite method is used when:

- You have a new machine. In this case, the hard disk or disks on which you are installing the BOS are empty. This is the only possible installation method for a new machine.
- You want to install onto a hard disk that contains an existing root volume group that you wish to completely overwrite. For example, this might occur if your root volume group has become corrupted.
- You want to reassign your hard disks, that is, to make your rootvg smaller and assign less disk space to it.

Note

The New and Complete Overwrite installation overwrites all data on the selected destination disk. This means that after the installation is complete, you will have to manually configure your system using the Configuration Assistant application, SMIT, or the command line. If you want to preserve your system configuration, and you do not need to completely overwrite your root volume group, do not use the New and Complete Overwrite option.

4.1.2 Migration Installation

Use this installation method to upgrade AIX Version 3.2, AIX Version 4.1, or AIX Version 4.2 to AIX Version 4.3 while preserving the existing root volume

group. With the exception of /tmp, this method preserves all file systems including the root volume group, logical volumes, and system configuration files. Migration is the default installation method for AIX Version 3.2, AIX Version 4.1, and AIX Version 4.2 machines.

In most cases, the user configuration files from the previous version of a product are saved when the new version is installed during a Migration installation.

4.1.3 Preservation Installation

Use this installation method when a version of the BOS is installed on your system, and you want to preserve the user data in the root volume group. However, this method overwrites the /usr, /tmp, /var, and / (root) file systems by default; so, any user data in these directories is lost. These file systems are removed and recreated; so, any other LPPs or filesets that you installed on the system will also be lost. System configuration must be done after doing a Preservation installation.

The /etc/preserve.list file contains a list of system files to be copied and saved during a preservation BOS installation. The /etc/filesystems file is listed by default. You can add the full path names of any additional files that you want to save during the Preservation installation to the preserve.list file. For example, you can alter the /etc/preserve.list file to tell your installation process that you want to preserve your /var file system.

For detailed information on installing the BOS, refer to *AIX Version 4.3 Installation Guide*, SC23-4112.

Once you have installed the BOS, and the system has booted from the hard disk, it will take you to the Installation Assistant menu. A screen similar to Figure 19 is shown.

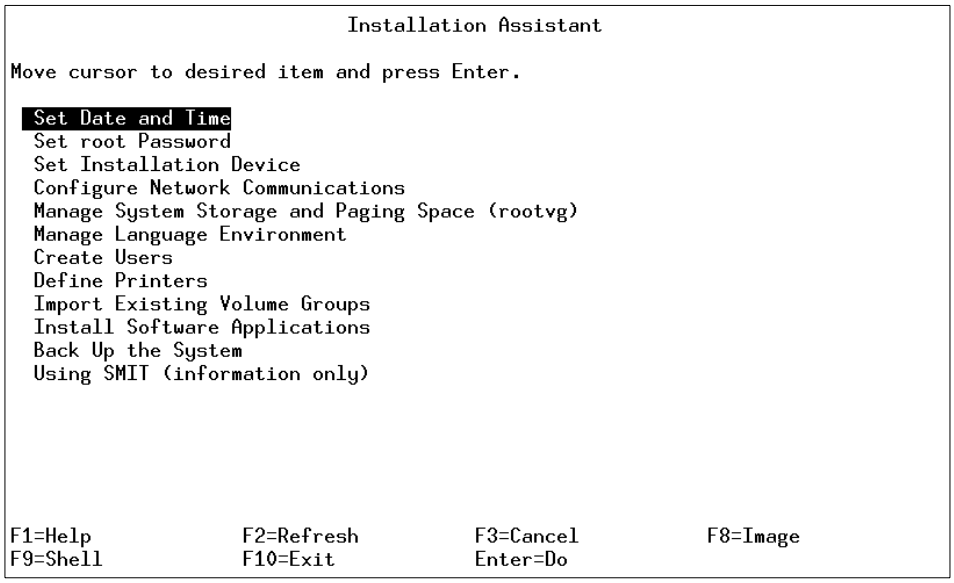

Figure 19. Installation Assistant Menu

You can do a number of tasks while you are in the Installation Assistant. If you need to call the Installation Assistant again, simply use the fast path `smitty assist`. All the changes that you make in the Install Assistant menu become available immediately. It is recommended that you make these changes when you are installing the operating system.

4.2 Understanding Maintenance Levels

Once you have installed the base operating system, you can determine the maintenance level of your AIX system. For this, use the `oslevel` command. The general syntax of the `oslevel` command is as follows:

```
oslevel [ -l Level | -g | -q ]
```

A brief description of the `oslevel` command flags is given in Table 19.

Table 19. oslevel Command Flags

Flag	Description
-l level	Lists filesets at levels earlier than the maintenance levels specified by the Level parameter.
-g	Lists filesets at levels later than the current maintenance level.

Flag	Description
-q	Lists names of known maintenance levels that can be specified using the -l flag.

To see what is the current maintenance level of your system, use the `oslevel` command as follows:

```
# oslevel

4.3.2.0
```

The product name and level number identify a software product. The level of a software product in AIX Version 4.3 is defined as vv.rr.mmmm.ffff, where:

vv Is a numeric field of one to two digits that identifies the version number.

rr Is a numeric field of one to two digits that identifies the release number.

mmmm Is a numeric field of one to four digits that identifies the modification level.

ffff Is a numeric field of one to four digits that identifies the fix level.

For example, bos.net.tcp.client 4.1.0.0 is a fileset, and bos.net.tcp.client 4.1.0.1 is an update to that fileset. If there is another fileset update, bos.net.tcp.client 4.1.0.2 is generated. This update will contain all the fixes that were in the bos.net.tcp.client 4.1.0.1. If a cumulative AIX update is generated, the mod level of the fileset will increment resulting in bos.net.tcp.client 4.1.1.0, which would contain all previous fixes.

4.3 Software Packaging

Software products include those shipped with AIX and those purchased separately. Each software product can contain separately installable parts. The following list explains how software products are organized.

Licensed Program A licensed program (also known as a product) is a complete software product including all packages associated with that licensed program. For example, the BOS (Base Operating System) is a licensed program.

Package	A group of separately installable units that provide a set of related functions. For example, bos.net is a package.
Fileset	An individually installable option. Filesets provide a specific function. For example, bos.net.nfs.client 4.3.0.0 is a fileset.
Fileset Update	An individually installable update. The fileset update either enhances or corrects a defect in a previously installed fileset. For example, bos.net.nfs.client 4.3.0.3 is a fileset update.
Bundle	A collection of packages, products, or individual filesets that suit a specific purpose, such as providing personal productivity software or software for a client machine in a network environment. A set of bundles is provided with the BOS that contain a specific set of optional software. The user_bundles directory is where users can create their own bundle files.

4.4 Installing Optional Software and Service Updates

Once you have installed the base operating system, only a limited number of filesets are installed on your system. For a complete listing of the software that is installed during the BOS installation, please refer to Appendix B of *AIX Version 4.3 Installation Guide,* SC23-4112.

In order to install additional software, you can use SMIT or the command line. If you decide to use the command line to install your software, you should be familiar with the `installp` command.

4.4.1 The installp Command

The `installp` command is used to install and update software. The `installp` command has a large number of flags. In the following sections, only the most important flags are shown with each command. The `installp` command is also used by all the SMIT scripts to install software.

4.4.1.1 Installing Optional Software

To install software with apply only or with apply and commit, the command syntax for the `installp` command is:

```
installp [ -a | -ac [ -N ] ] [ -eLogFile ] [ -V Number ] [ -dDevice ] [ -b
] [ -S ] [ -B ] [ -D ] [ -I ] [ -p ] [ -Q ] [ -q ] [ -v ] [ -X ] [ -F | -g
```

```
] [ -O { [ r ] [ s ] [ u ] } ] [ -tSaveDirectory ] [ -w ] [ -zBlockSize ] {
FilesetName [ Level ]... | -f ListFile | all }
```

For example, in order to install all filesets within the bos.net software package in /usr/sys/inst.images directory, enter:

```
installp -aX -d/usr/sys/inst.images bos.net
```

Execution of this command will install the bos.net filesets and will automatically commit them as well.

4.4.1.2 Committing Applied Updates

To commit applied updates, the command syntax for `installp` command is:

```
installp -c [ -eLogFile ] [ -VNumber ] [ -b ] [ -g ] [ -p ] [ -v ] [ -X ] [
-O { [ r ] [ s ] [ u ] } ] [ -w ] { FilesetName [ Level ]... | -f ListFile
| all }
```

For example, in order to commit all updates, enter:

```
installp -cgX all
```

Execution of this command will commit all the updates and will remove the previous version's filesets.

4.4.1.3 Rejecting Applied Updates

To reject the updates that are in the applied state, the command syntax for the `installp` command is:

```
installp -r [ -eLogFile ] [ -VNumber ] [ -b ] [ -g ] [ -p ] [ -v ] [ -X ] [
-O { [ r ] [ s ] [ u ] } ] [ -w ] { FilesetName [ Level ]... | -f ListFile }
```

For example, in order to reject all updates that were applied to the bos.net package, enter:

```
installp -rBpX bos.net
```

Execution of this command will remove all the uncommitted updates and bring the system back to the previous maintenance level.

4.4.1.4 Removing Installed Software

If you want to remove an installed product, that is, remove all files that belong to that software from the system, the command syntax for the `installp` command is:

```
installp -u [ -eLogFile ] [ -VNumber ] [ -b ] [ -g ] [ -p ] [ -v ] [ -X ] [
-O { [ r ] [ s ] [ u ] } ] [ -w ] { FilesetName [ Level ]... | -f ListFile }
```

For example, in order to remove bos.net files that belong to that product in a preview mode, enter:

```
installp -ugp -V2 bos.net
```

Execution of this command will give you a list of files that will be removed and will not actually run the command.

4.4.1.5 Cleaning Up After Failed Installations

If an installation fails, `installp` will not be able to install the same software until you perform a clean operation. Therefore, in order to remove the incomplete filesets that were installed when the installation failed, you can use the `installp` command as follows:

```
installp -C [ -b ] [ -eLogFile ]
```

For example, if all the prerequisites in an installation are not met, the `installp` command might fail. You will not be able to reinstall the product until you have done a cleanup. In order to do this, enter:

```
installp -C
```

This will remove all the files installed in the failed installation.

4.4.1.6 Listing All Installable Software on Media

In order to see what software is available on a particular media, the command syntax for the `installp` command is:

```
installp { -l | -L } [ -eLogFile ] [ -d Device ] [ -B ] [ -I ] [ -q ] [
-zBlockSize ] [ -O { [ s ] [ u ] } ]
```

For example, in order to list the software that is on your CD-ROM, enter:

```
installp -L -d /dev/cd0
```

The flags commonly used with the `installp` command are listed in Table 20.

Table 20. installp Command Flags

Flag	Description
-a	Applies one or more software products or updates. This is the default action. This flag can be used with the -c flag to apply and commit a software product update when installed.
-B	Indicates that the requested action should be limited to software updates.
-C	Cleans up after an interrupted installation and attempts to remove all incomplete pieces of the previous installation.

Flag	Description
-d Device	Specifies where the installation media can be found.
-p	Performs a preview of an action by running all preinstallation checks for the specified action. This flag is only valid with apply, commit, reject, and remove (-a, -c, -r, and -u) flags.
-f ListFile	Reads the names of the software products from ListFile. If ListFile is a - (dash), it reads the list of names from the standard input. Output from the `installp -l` command is suitable for input to this flag.
-X	Attempts to expand any file systems where there is insufficient space to do the installation.
-V Number	Specifies the verbose option that provides four levels of detail for preinstallation output. The valid values for the Number parameter are 2, 3, or 4.
-u	Removes the specified software product and any of its installed updates from the system. Removal of any bos.rte fileset is never permitted.

4.4.2 Using smitty install_update

SMIT can be used to install software and updates. A number of menus are available to you for these tasks. To install software products, use the SMIT fast path:

1. `smitty install_latest`

A screen similar to Figure 20 is shown.

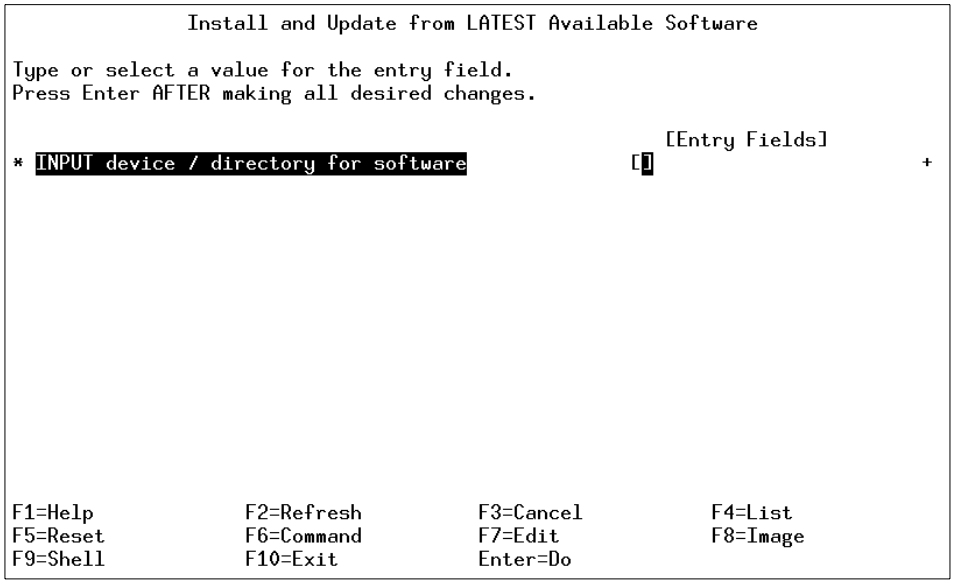

Figure 20. installp - Step 1

2. Enter the device name for installation in INPUT device /directory for software field. A screen similar to Figure 21 is shown:

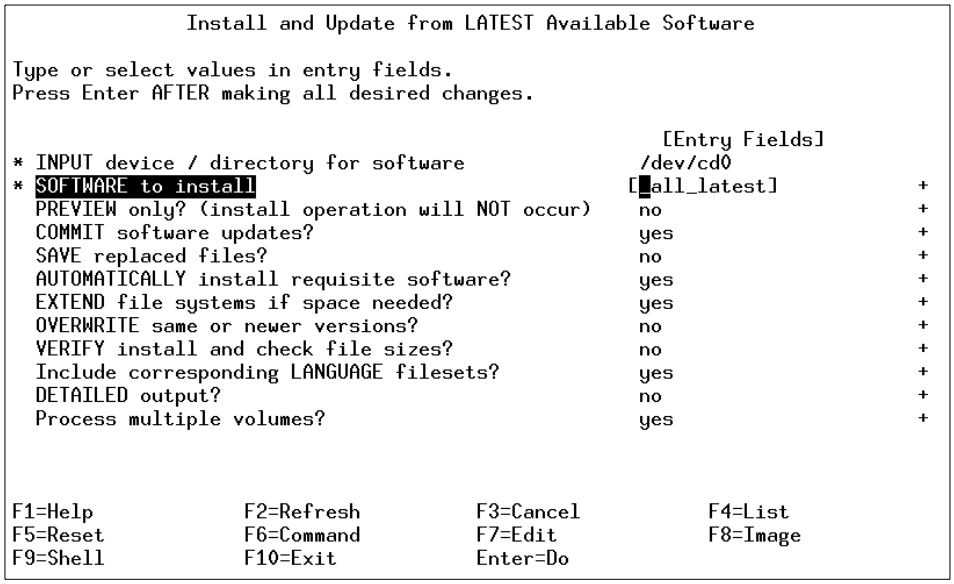

Figure 21. installp - Step 2

3. In the SOFTWARE to install field, either enter the name, if you know what you have to install, or press **F4** to get a list of all the available software. Press **Enter** once you have selected the products you want to install.
4. It is recommended that you first verify that the software you are trying to install meets all the prerequisite and co-requisite requirements. It is a good practice to set the PREVIEW only? (install operation will NOT occur) field to **YES**. This will give you a detailed listing of whether your installation will be successful or not.
5. It is recommended that you accept the default values for the AUTOMATICALLY install requisite software (default YES) and EXTEND file systems (default YES) fields if space is needed. Your installation might fail if you tell `installp` not to extend the file system if it runs out of space. An error similar to the one shown below can be encountered:

   ```
   0503-008 installp: There is not enough free disk space in file system
   /usr (506935 more 512-byte blocks are required). An attempt to extend
   this file system was unsuccessful. Make more space available, then retry
   this operation.
   ```

6. Press **Enter**.
7. Look at the error messages, if any, at the end of the command execution when the command status changes to failed. It is recommended that you look at your smit.log even if the command status reports OK since there may be filesets that you wanted to install which the system did not attempt to install.

Once you have read the log, and there are no misses and failures, you have successfully installed the optional software.

Note

If you try to run two `installp` commands at a time from the same installation medium, it will fail with an error similar to:

```
0503-430 installp: Either there is an installp process currently running
or there is a previously failed installation. Wait for the process to
complete or run installp -C to cleanup a failed installation.
```

4.5 Software Products and Update Maintenance

During and after the installation, there are four major actions that can be taken with optional software products and service updates. Optional software and service updates can be applied, committed, rejected, and removed.

4.5.1 Apply Action

When a service update is installed, it enters the applied state and becomes the currently active version of the software. When an update is in the applied state, the previous version is stored in the /usr/lpp/*PackageName* directory so that if you want to return to the former version, you can do so without having to reinstall it. Use `installp -s` to get a list of all products and updates in the applied state.

4.5.2 Commit Action

When you commit software, the saved files from all previous versions of the software product are removed from the system, thereby, making it impossible to return to the previous version of the software product. Use `installp -ac` to commit the software at installation time. You can also commit installed software or software updates in the applied state by using SMIT. SMIT gives you a list of products in the applied state. You can optionally choose to select one software update or select all to commit all the software updates that are in the applied state.

In order to commit an applied software update, use the SMIT fast path:

1. `smitty install_commit`

   A screen similar to Figure 22 is shown.

```
                Commit Applied Software Updates (Remove Saved Files)

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

                                                        [Entry Fields]
* SOFTWARE name                                        [all]                +
  PREVIEW only? (commit operation will NOT occur)      no                   +
  COMMIT requisites?                                   yes                  +
  EXTEND file systems if space needed?                 yes                  +
  DETAILED output?                                     no                   +

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

Figure 22. Commit Software Updates

2. Press **Enter**. The system reports the software that are about to be committed and then removes the copies from the /usr/lpp/*PackageName* directory. In order to achieve the same from the command line, use the command:

   ```
   installp -Cox all
   ```

4.5.3 Reject Action

When you reject an applied service update, the update's files are deleted, and the Software Vital Product Data database information is changed to indicate that the update is no longer on the system. The previous version of the system is restored and becomes the active version of the software. In order to reject a service update that you have installed, use the SMIT fast path:

1. `smitty install_reject`

   A screen similar to Figure 23 is shown.

```
              Reject Applied Software Updates (Use Previous Version)

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

                                                      [Entry Fields]
* SOFTWARE name                                      [ ]                +
  PREVIEW only? (reject operation will NOT occur)     no                +
  REJECT dependent software?                          no                +
  EXTEND file systems if space needed?                yes               +
  DETAILED output?                                    no                +

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

Figure 23. Rejecting Software Updates

2. Press **F4** on the SOFTWARE name field to select the software update you want to reject. All the software updates that are in the applied state will be listed. Select the update that you want to reject, and press **Enter**.

This will remove the software update files from the system, restore the previous version files, and update the Software Vital Product Data database.

You can also achieve the same objective using the `installp` command. On the command line, enter:

```
installp -rBpX -f <File Name>
```

where `<File Name>` is the name of the file that contains a list of software updates that you want to reject. You will have to create this file manually using any editor of your choice.

4.5.4 Remove Action

You can also remove a software product completely. When a software product is removed, all product files are removed from the system, and the Software Vital Product Data database is changed to indicate that the product is removed. Once a product is removed, there will no longer be a version of that product running on the system. You can remove software by using the SMIT fast path:

1. `smitty install_remove`

   A screen similar to Figure 24 is shown:

```
                          Remove Installed Software

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

                                                      [Entry Fields]
* SOFTWARE name                                      [1]                +
  PREVIEW only? (remove operation will NOT occur)     yes                +
  REMOVE dependent software?                          no                 +
  EXTEND file systems if space needed?                no                 +
  DETAILED output?                                    no                 +

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

Figure 24. Removing Software

2. Press **F4** in the SOFTWARE name field to get a list of all the software that is installed on your system. Select the software you want to remove by pressing **F7** followed by **Enter** once you are done.

3. PREVIEW only? (remove operation will not occur) field is yes by default. This allows you to preview any remove operations and confirm your choices before you actually do the remove action.
4. Once you are sure that you want to remove this software, change PREVIEW only? (remove operation will not occur) field to **No**, and press **Enter**. This will remove all the software that you have selected to be removed.

You can also remove the software using the command line. On the command line, enter:

```
installp -ugp -V2 -f <File Name>
```

where `<File Name>` is a user-created file that will contain the names of the software that you want to remove.

4.6 Maintaining Optional Software (Applying Updates)

Software that is distributed to fix a problem in a product is called an update. All software products have a version number and a release number that identify the release level of the product. In addition to this, product updates are assigned a modification level number and a fix level number to identify the level of the update. See 4.2, “Understanding Maintenance Levels” on page 73 for information on maintenance levels.

Suppose that you have your system currently running 4.3.1.0, and all the filesets are at 4.3.1.0 maintenance level. IBM has just released a latest maintenance level for systems on 4.3.1.0. You have to upgrade your system to bring it to the latest maintenance level.

Bringing a system to the latest maintenance level involves a number of steps that are listed below:

- Listing the Current Maintenance Level of the System
- Downloading the latest fixes using the FIXDIST tool
- Installing the FixPack

4.6.1 Listing the Current Maintenance Level of the Software

The `lslpp` command displays information about installed filesets or fileset updates. The FilesetName parameter is the name of a software product. The FixID (also known as PTF or program temporary fix ID) parameter specifies the identifier of an update to an AIX 3.2 formatted fileset. In order to see what maintenance level your filesets are currently on, use the command:

```
lslpp -l
```

This will list all the software that is installed on your system showing the current maintenance level. An output similar to Figure 25 is shown.

```
  Fileset                      Level  State      Description
  ----------------------------------------------------------------------------
Path: /usr/lib/objrepos
  bos.acct                   4.3.1.0  COMMITTED  Accounting Services
  bos.adt.base               4.3.1.0  COMMITTED  Base Application Development
                                                 Toolkit
  bos.adt.debug              4.3.1.0  COMMITTED  Base Application Development
                                                 Debuggers
  bos.adt.graphics           4.3.1.0  COMMITTED  Base Application Development
                                                 Graphics Include Files
  bos.adt.include            4.3.1.0  COMMITTED  Base Application Development
                                                 Include Files
  bos.adt.lib                4.3.1.0  COMMITTED  Base Application Development
                                                 Libraries
  bos.adt.libm               4.3.1.0  COMMITTED  Base Application Development
                                                 Math Library
  bos.adt.prof               4.3.1.0  COMMITTED  Base Profiling Support
  bos.adt.prt_tools          4.3.0.0  COMMITTED  Printer Support Development
                                                 Toolkit
  bos.adt.samples            4.3.1.0  COMMITTED  Base Operating System Samples
  bos.adt.sccs               4.3.1.0  COMMITTED  SCCS Application Development
                                                 Toolkit
  bos.adt.syscalls           4.3.1.0  COMMITTED  System Calls Application
:
```

Figure 25. lslpp -l Command Output

4.6.2 Downloading Fixes

IBM provides a number of mirrored sites on the Internet where you may freely download AIX-related fixes. The current anonymous FTP servers are shown in Table 21.

Table 21. Current FTP Servers

Country	URL	IP Address
Canada	fixdist.aix.can.ibm.com	204.138.188.126
Germany	www.ibm.de	192.109.81.2
Japan	fixdist.yamato.ibm.co.jp	203.141.89.41
United Kingdom	ftp.europe.ibm.com	193.129.186.2
United States	service.software.ibm.com	198.17.57.66

To help customers browse and download fixes stored at the fix sites, IBM has released a freely available service tool called FixDist. FixDist is a tool designed to enable customers to select and download a fix and any necessary requisite fixes.

FixDist and the user guide are available using an anonymous FTP from any of the servers listed above. Many of these sites are also Web servers (an example URL is: `http://service.software.ibm.com`).

Once you have installed and set up the FixDist tool on your AIX system, the next step is to download the updates you want. On the command line, enter:

1. `fixdist`

   A screen similar to Figure 26 is shown.

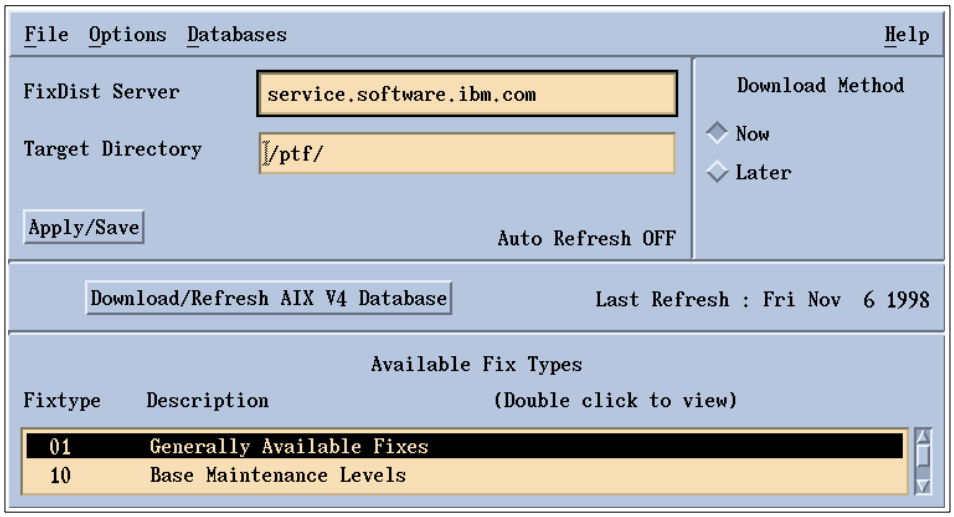

Figure 26. fixdist - Step 1

   In this case, you have chosen to download all our PTFs to the /ptf file system. It is possible that you might be running a number of different releases of AIX in your environment. In this case, it is recommended that you keep your update downloads in different directories naming them according to the release level. In this example, we need to set the target directory field to the /ptf/aix431 directory.

2. Click on **Generally Available Fixes** to list what updates are available from IBM. A screen similar to Figure 27 is shown.

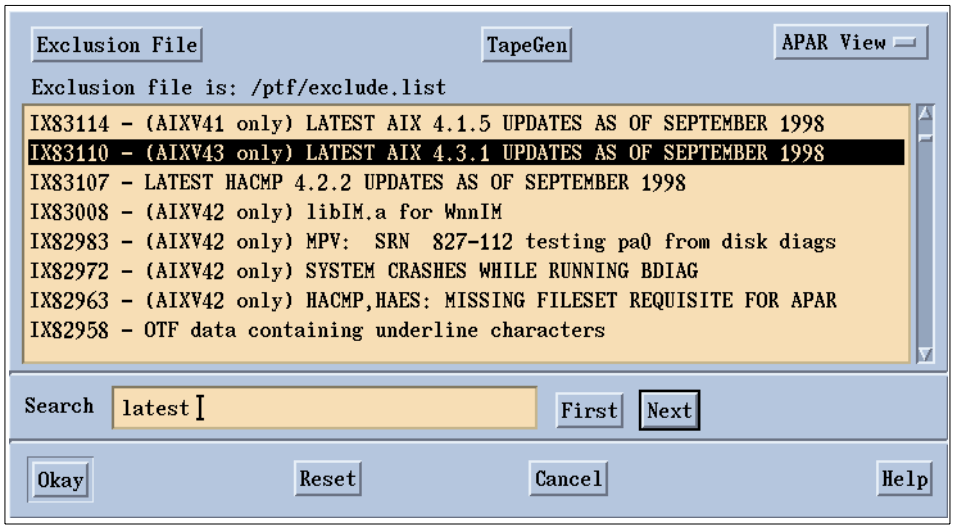

Figure 27. fixdist - Step 2

3. Select the updates you want to apply to your system by clicking on the name of the update/fix. In this case, since you are applying the latest updates for AIX 4.3.1.0, select the latest fixes for 4.3.1.0.
4. After you have selected the updates you want, you have the option to preview what will be downloaded, the estimated size of the images that will be downloaded, and so on. It is a good practice to download all your fixes into one file system.

FixDist will download all the fixes in the directory given at the start of the FixDist process as shown in Figure 26. All the files are downloaded in the bff format. bff stands for *Backup File Format*, which means that the file was created using the AIX `backup` command and can be read using the AIX `restore` command. In addition to the .bff files, .info files are also downloaded that give a brief summary of what the fileset is for and what has been fixed by this fileset.

If you apply updates frequently and keep all the updates in the same directory, then the .toc file might be outdated. The command `installp` uses the .toc file to carry out installations. In order to have the correct and latest software installed when you actually do the installation, it is recommended that you rebuild the .toc file. This can be done by using the `inutoc` command. The general syntax of `inutoc` command is:

```
inutoc [Directory name]
```

The inutoc command creates a .toc file for directories that have backup format file install images. This command is used automatically by the installp command and the install script if no .toc file is present but is not run if a .toc file already exists.

4.6.3 Displaying and Updating Installed Software to the Latest Level

Once you have downloaded all the fixes into the /ptf directory, the next step is to install them and bring your system to the latest maintenance level. In this section, the following procedures are discussed:

- How you can install an individual fix using: instfix
- How you can use update_all to update your complete system.

4.6.3.1 Displaying An Individual Fix (instfix Command)

You can download an individual fix using FixDist following the same procedure given in 4.6.2, “Downloading Fixes” on page 85. In order to find out if a fix is installed on your system or to install a fix, use the instfix command. The general syntax of the instfix command is as follows:

```
instfix [ -T ] [ -s String ] [ -S ] [ -k Keyword | -f File ] [ -p ] [ -d
Device ] [ -i [ -c ] [ -q ] [ -t Type ] [ -v ] [ -F ] ] [ -a ]
```

The general flags used with instfix command are given in Table 22.

Table 22. instfix Command Flags

Flag	Description
-d Device	Specifies the input device. Required for all flags except -i and -a.
-i	Displays whether fixes or keywords are installed.
-k Keyword	Specifies an APAR number or keyword to be installed. Multiple keywords can be entered. A list of keywords entered with the -k flag must be contained in quotation marks and separated with spaces.
-v	Used with the -i flag to specify verbose mode. Displays information about each fileset associated with a fix or keyword.
-s String	Searches for and displays fixes on media containing a specified string.

The instfix command allows you to install a fix or set of fixes without knowing any information other than the Authorized Program Analysis Report (APAR) number or other unique keywords that identify the fix.

Any fix can have a single fileset or multiple filesets that comprise that fix. Fix information is organized in the Table of Contents (TOC) on the installation

media. After a fix is installed, fix information is kept on the system in a fix database. The `instfix` command can also be used to determine if a fix is installed on your system.

On the command line, enter:

```
# instfix -ivk IX57214
IX57214 Abstract: dce login returns error without prompt for password
Fileset dce.client.core.rte.security:2.1.0.10 is applied on the system.
Fileset dce.msg.en_US.client.core.rte:2.1.0.6 is applied on the system.
All filesets for IX57214 were found.
```

In order to list all the fixes that are installed on your system enter the command:

```
# instfix -iv
IX81899 Abstract: HOT: lava asserted

    Fileset bos.net.nfs.cachefs is not applied on the system.
    Fileset bos.net.nfs.client:4.3.2.0 is applied on the system.
    All filesets for IX81899 were found.
IX81900 Abstract: HOT:titan crashed on 9832B

    Fileset bos.net.nfs.cachefs is not applied on the system.
    Not all filesets for IX81900 were found.
```

You can also use SMIT to find out what fixes are installed on your system. Use the SMIT fast path:

1. `smitty show_apar_stat`

   A screen similar to Figure 28 is shown.

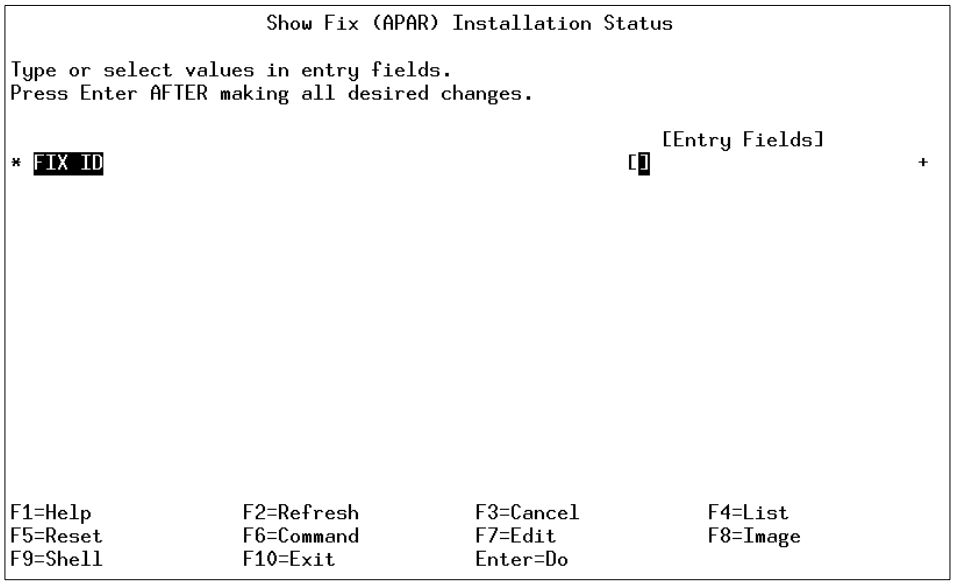

Figure 28. instfix Device Input

2. Press **F4** in the FIX ID field to get a list of all the fixes that are installed on the system. The output from this command is similar to the `instfix -iv` command.

4.6.3.2 Installing an Individual Fix by APAR Number

In order to install the fixes using SMIT, use the SMIT fast path:

1. `smitty instfix` or `smitty update_by_fix`
2. In the INPUT device / directory for the software field, enter the name of the device (or directory if you downloaded the fixes to your system) from which to install the fixes and press **Enter.** A screen similar to Figure 29 is shown.

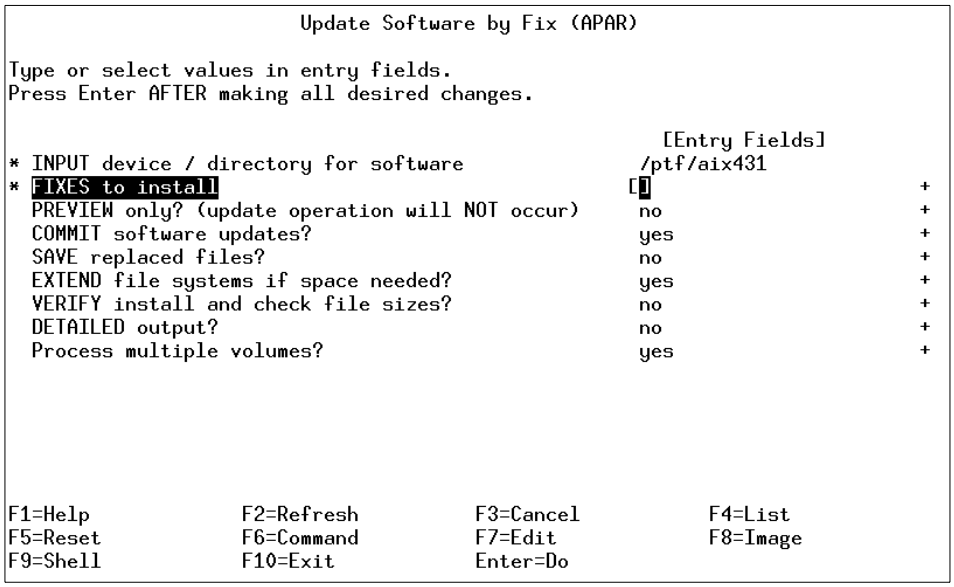

Figure 29. instfix Fix Selection

3. In the FIXES to Install field, press **F4** to get a list of fixes that are available on the media and select the fixes you want to install.
4. Press **Enter**.

The system will update the maintenance level of the fileset you selected. You have successfully updated the maintenance level of your software.

4.6.3.3 Updating All FileSets to the Latest Level

In order to install all new fixes that are available through IBM, use the fast path:

1. `smitty update_all`

A screen similar to Figure 30 is shown.

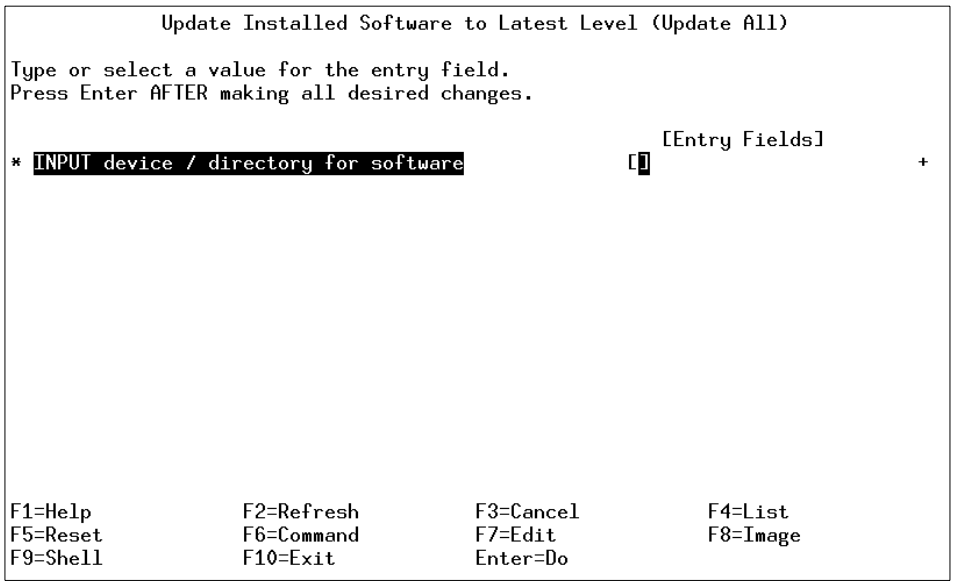

Figure 30. update_all - Step 1

2. In the INPUT device/directory for software field, enter the name of the device (or directory if you have fixes on your hard disk) from which installation will be carried out. Press **Enter**.

A screen similar to Figure 31 is shown.

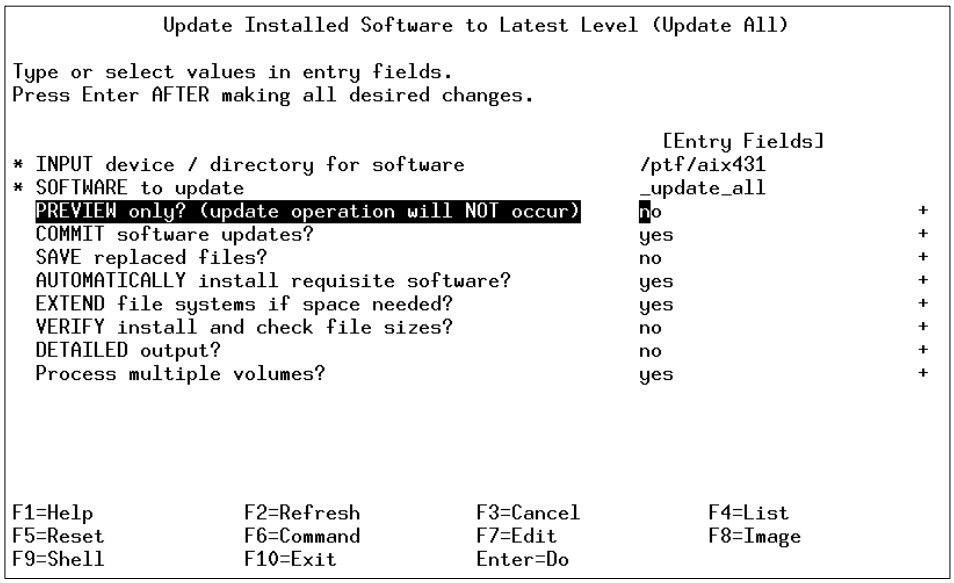

Figure 31. update_all - Step 2

3. It is best to set the PREVIEW only? (update operation will NOT occur) field to YES by pressing the **Tab** key. The Preview option makes a dry run of the task you are trying to perform and reports any failures that might be encountered when you do the actual installation. This will ensure that your installation does not fail.

Once you are sure that there are no prerequisites that you are missing, you can do the actual installation. This procedure will update your software to the latest maintenance level.

In order to view the new maintenance level of your software, on the command line enter:

```
lslpp -l
```

This will show you the latest maintenance level of the filesets including those you just updated.

4.7 Creating Installation Images on a Hard Disk

Installable image files (or installation packages) can be copied to the disk for use in future installations. These image files will be copied from your

installation media (tape or diskette) to a directory on the disk so that they may be installed later using the disk directory as the input device. These files will be copied to the directory named /usr/sys/inst.images.

In order to create installation images on your hard disk, use the SMIT fast path:

1. `smitty bffcreate`

   A screen similar to Figure 32 is shown:

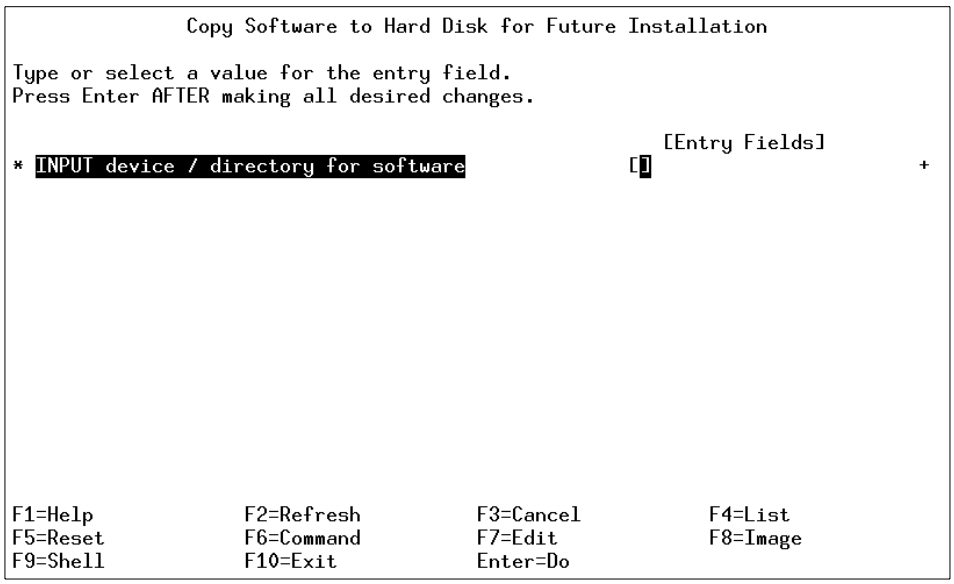

Figure 32. Creating Installable Images on Hard Disk

2. In the **I**NPUT device/directory for software field, enter the name of your source that will be used to copy the images and press **Enter**.
3. On the next screen, press **F4** on the Software package to copy field to get a list of the software available on the media. Select the installation images you want to copy to your hard disk and press **Enter**.
4. All the images will be copied to your hard disk in the /usr/sys/inst.images directory.

For future installations, enter the /usr/sys/inst.images directory in the INPUT device / directory for software field. If for some reason your .toc file gets corrupted, you will receive an error either in SMIT or the command line, depending on what are you using, similar to:

```
0503-005 The format of .toc file is invalid
```

In this case, simply use `inutoc` command to recreate your .toc file.

This method of creating installation images is helpful in situations where the software you are trying to install has co-requisites that are on a different media, and your installation process is not smart enough to let you change the media it is currently processing. In such situations, your installation will fail; therefore, it is recommended to have all the prerequisites and co-requisites reside in one directory and then do the installation.

4.8 Alternate Disk Installation

Alternate disk installation, available in AIX Version 4.3, allows installing the system while it is still up and running, which allows install or upgrade downtime to be decreased considerably. It also allows large facilities to manage an upgrade because systems can be installed over a longer period of time while the systems are still running at the existing version. The switch over to the new version can then happen with a simple reboot.

4.8.1 Filesets Required

Alternate disk installation requires the following filesets to be installed before you are able to use the functions. The filesets are:

- bos.alt_disk_install.boot_images filesets must be installed for alternate disk `mksysb` installs if Network Install Management (NIM) is not being used.
- bos.alt_disk_install.rte fileset must be installed for `rootvg` cloning.

Once you have installed these filesets, the alternate disk installation functions are available to you in the Software Installation and Maintenance menu. Use the SMIT fast path:

`smitty alt_install`.

A screen similar to Figure 33 is shown.

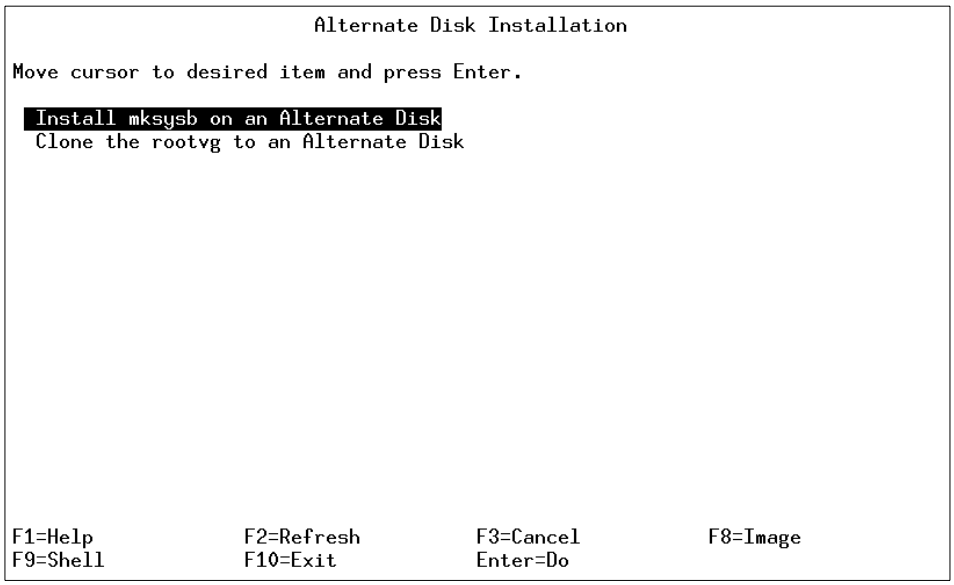

Figure 33. Alternate Disk Installation

Alternate disk installation can be used in one of two ways:

- Cloning the current running rootvg to an alternate disk.
- Installing a `mksysb` image on another disk.

4.8.2 Alternate Disk rootvg Cloning

Cloning the rootvg to an alternate disk can have many advantages.

- Having an online backup available in case of disaster. Keeping an on-line backup requires that an extra disk or disks to be available on the system.
- Applying new maintenance levels or updates. A copy of the rootvg is made to an alternate disk, then updates are applied to that copy. Finally, the boot list is updated to boot from the new device. The system runs uninterrupted during this time. When it is rebooted, the system will boot from the newly updated rootvg for testing. If updates cause problems, the old rootvg can be retrieved by resetting the `bootlist` and rebooting.

In order to clone your rootvg to a new disk, do the following procedure:

Use the SMIT fast path:

1. `smitty alt_clone`

A screen similar to Figure 34 is shown.

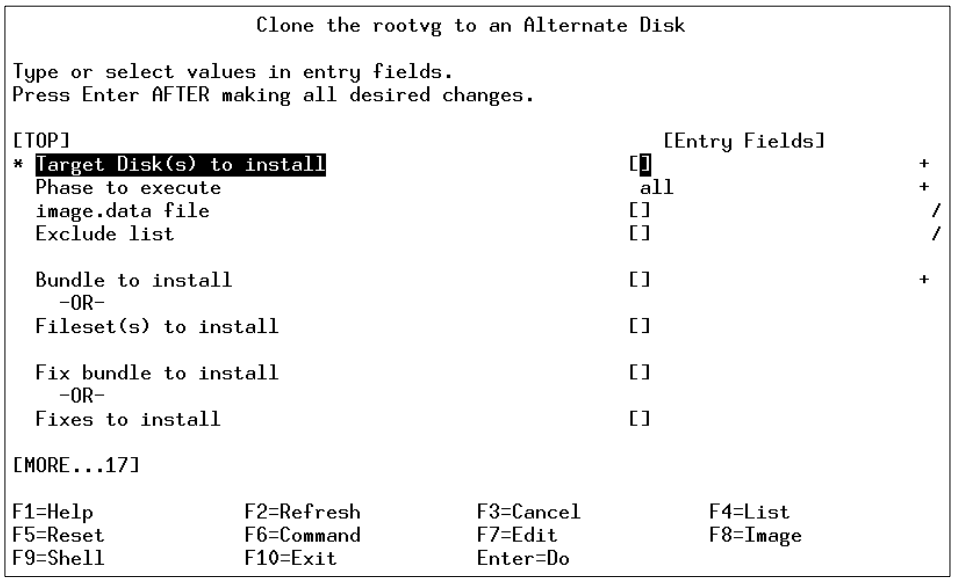

Figure 34. smitty alt_clone

2. In the Target Disk(s) to install field, enter the name of the disk you want to use for making the clone. The target disk should be a stand-alone disk not belonging to a volume group. In addition to this, SSA disks cannot be used as your target disks.
3. The Phases to execute field defaults to all. Accept the default for now.
4. In the Exclude list field, you can create a file that will contain the names of all the files and directories that you do not want to be copied to your cloned system.
5. Specify the name of any additional bundles or filesets and fixes that you want to install in the Bundle to install and Fix to Install fields. The use of these fields allows service to be installed as part of the clone process.
6. Specify the name of the input device in case you have selected to install any additional software in the Directory or Device with images field.
7. If you want your system to start from your alternate rootvg on the next system start-up, set the Set the bootlist to boot from this disk on next boot to YES
8. Press **Enter**.

The following sequence of output is shown in SMIT while the system is cloning to the new disk:

```
Calling mkszfile to create new /image.data file.
Checking disk sizes
Creating cloned rootvg volume group and associated logical volumes
Creating Logical volume alt_hd5
Creating Logical volume alt_hd6
Creating Logical volume alt_hd8
Creating Logical volume alt_hd4
Creating Logical volume alt_hd2
Creating Logical volume alt_hd9var
Creating Logical volume alt_hd3
Creating Logical volume alt_hd1
Creating /alt_inst / file system
Creating /alt_inst/usr file system
Creating /alt_inst/var file system
Creating /alt_inst/tmp file system
Creating /alt_inst/home file system
Generating a list of files
for backup and restore into the alternate file system ...
Backing up the rootvg files and restoring them to the
alternate File Systems
Modifying ODM on cloned disk
Building boot image on cloned disk
Forced umount of /alt_inst/home
Forced umount of /alt_inst/tmp
Forced umount of /alt_inst/var
Forced umount of /alt_inst/usr
Forced umount of /alt_inst/
Changing logical volume names in Volume Group Descriptor Area
Fixing Logical Volume control blocks
Fixing File system super blocks
Bootlist is set to the bootdisk:hdisk1
```

By default, the bootlist will be set to the new cloned rootvg for the next reboot. This completes the cloning of the rootvg using the `alt_disk_install` command.

4.8.3 Alternate mksysb Install

An alternate mksysb install involves installing a mksysb image that has already been created from another system onto an alternate disk of the target system. The mksysb image (AIX Version 4.3 or later) would be created on a system that was either the same hardware configuration as the target system or would have all the device and kernel support installed for a different machine type or platform and/or different devices.

In order to create the alternate mksysb system, use the SMIT fast path:

1. `smitty alt_mksysb`

   A screen similar to Figure 35 is shown:

```
                    Install mksysb on an Alternate Disk

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

                                                      [Entry Fields]
* Target Disk(s) to install                          []                      +
* Device or image name                               []                      +
  Phase to execute                                    all                    +
  image.data file                                    []                       /
  Customization script                               []                       /
  Set bootlist to boot from this disk
  on next reboot?                                     yes                    +
  Reboot when complete?                               no                     +
  Verbose output?                                     no                     +
  Debug output?                                       no                     +
  resolv.conf file                                   []                       /



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

Figure 35. smitty alt_mksysb

2. Enter the name of the disk on which you want to install the mksysb in the Target Disk(s) to install field.
3. Enter the name of the device or the image name from which you will be restoring the mksysb in the Device or image name field.
4. Press **Enter**.

Once the mksysb image is restored to the new disk, the system reboots from the new alternate rootvg. This completes your alternate mksysb installation.

4.9 Quiz

The following questions are designed to help you verify your knowledge of this chapter.

1. During the first reboot after the AIX Version 4.3 operating system installation process has completed, what is the first screen the administrator will see?

   A. Login prompt

B. Root shell prompt

C. Installation Assistant

D. Configuration Assistant

2. Which of the following commands lists the current fix level of the bos.net.nfs client fileset?

   A. `lsfs bos.net.nfs.client`

   B. `lslpp -l bos.net.nfs.client`

   C. `lppchk -l bos.net.nfs.client`

   D. `installp -ver bos.net.nfs.client`

3. Which of the following commands can be used to verify the success of an operating system upgrade?

   A. `oslevel`

   B. `lslpp -h bos.obj`

   C. `what_fileset -v`

   D. `lsattr -Vl bos.rte`

4. If bos.up displays on your machine as being at 4.3.1.7, what is the modification level?

   A. 1

   B. 3

   C. 4

   D. 7

4.9.1 Answers

The following are the answers to the previous questions:

1. C
2. B
3. A
4. A

4.10 Exercises

Provided here are some exercises you may wish to perform:

1. Try to the run `installp` command twice at the same time on one system and see what happens.
2. You have just installed a new release of the operating system, determine the operating system level of your system.
3. What is a fileset, package, bundle? Explain.
4. Your root file system is behaving strangely; therefore, you decide to do a preserve install. However, you do not want to overwrite your /var file system. What can be done to prevent this? Perform the preserve install and save your /var file system as is.
5. Your installation is failing repeatedly because of missing prerequisites. How will you use preview option to obtain all the prerequisite information in SMIT?
6. What are the methods available to you to upgrade your system to the latest release/maintenance level yet minimize the downtime?
7. If prerequisites from two install medias point to each other, what is the best method that you can use to complete the installation without errors?
8. What are the different methods of installation available to you for installing a base operating system?
9. Use the installation assistant to set the time and paging size on your system.
10. Update your system to bring all the filesets to the latest fix level.
11. IBM has just announced a new fix pack. Obtain the fixpack from the IBM FTP site and apply the fixes to upgrade your system to the latest fix level.
12. Determine the latest fix level on your system.
13. Find out the latest fix level of a licensed program, filesets, and so on.
14. How do you use the `installp` command, and what are the different options that are available to you?
15. You have just downloaded a latest fix from IBM, but before you go into production, you want to test run the system with the latest fix pack installed. Use the alternate disk install to make a replica of your system and test out the changes with the fix pack installed.
16. Find out what are the different filesets you have and their state using the `installp` command. Next, commit any applied software and remove any

fileset that you think is not required. Also, apply a fix pack and then reject the changes made by this fixpack.

17. Download an individual fix and use SMIT to install the fix.

18. Download any package from your installation media to your disk, create a new table of contents for the /usr/sys/inst.images directory, and install the package using SMIT.

Chapter 5. Object Data Manager

The ODM has many purposes. Its primary functions are to maintain the RISC System/6000 configuration, associated devices, and the vital product database. In addition, it provides a more robust, secure, and sharable resource than the ASCII files previously used in AIX.

System data managed by the ODM includes:

- Device configuration information
- Display information for SMIT (menus, selectors, and dialogs)
- Vital product data for installation and update procedures
- Communications configuration information
- System resource information

Most system object classes and objects are stored in the /usr/lib/objrepos directory; however, ODM information is stored in three directories as follows:

- /usr/lib/objrepos
- /usr/share/lib/objrepos
- /etc/objrepos

The basic components of the ODM are object classes and objects. To manage object classes and objects, you use the ODM commands and subroutines. Specifically, you use the create and add features of these interfaces to build object classes and objects for storage and management of your own data.

A summary of the ODM concepts is provided in Table 23.

Table 23. ODM Concepts

Item	Definition	Similar to	Similar to
Object Class	A stored collection of objects with the same definition.	An array of C-Language structures.	A file with fixed format records.
ODM Object	A member of a defined ODM object class. An entity that requires management and storage of data.	An element of an array structure.	One of the fixed format records.

Item	Definition	Similar to	Similar to
ODM Database.	A stored collection of ODM object classes.	A collection of structure arrays.	A directory of files.

An object class comprises one or more descriptors. Values are associated with the descriptors of an object when the object is added to an object class. The descriptors of an object and their associated values can be located and changed with the ODM facilities.

In the area of device configuration, the ODM contains information about all configured physical volumes, volume groups, and logical volumes. This information mirrors the information found in the VGDA. The process of importing a VGDA, for example, involves copying the VGDA data for the imported volume group into the ODM. When a volume group is exported, the data held in the ODM about that volume group is removed from the ODM database.

5.1 ODM Commands

You can create, add, change, retrieve, display, and delete objects and object classes with ODM. ODM commands are entered on the command line.

Note

ODM commands should be used only when traditional methods of system maintenance, such as SMIT, are ineffective. For a beginning system administrator, it is recommended that you perform additional reading and exercises before using these commands. Incorrect use of these commands may result in a disabled system. The ODM commands are described here for introductory purposes.

These commands are:

`odmadd` Adds objects to an object class. The `odmadd` command takes an ASCII stanza file as input and populates object classes with objects found in the stanza file.

`odmchange` Changes specific objects in a specified object class.

`odmcreate` Creates empty object classes. The `odmcreate` command takes an ASCII file describing object classes as input and produces C language .h and .c files to be used by the application accessing objects in those object classes.

odmdelete	Removes objects from an object class.
odmdrop	Removes an entire object class.
odmget	Retrieves objects from object classes and puts the object information into odmadd command format.
odmshow	Displays the description of an object class. The odmshow command takes an object class name as input and puts the object class information into odmcreate command format.

5.2 Example of an Object Class for an ODM Database

The following is an example of the object class definition for the Customized Device Database (CuDv):

```
# odmshow CuDv
class CuDv {
        char name[16];                                  /* offset: 0xc ( 12) */
        short status;                                  /* offset: 0x1c ( 28) */
        short chgstatus;                               /* offset: 0x1e ( 30) */
        char ddins[16];                                /* offset: 0x20 ( 32) */
        char location[16];                             /* offset: 0x30 ( 48) */
        char parent[16];                               /* offset: 0x40 ( 64) */
        char connwhere[16];                            /* offset: 0x50 ( 80) */
        link PdDv PdDv uniquetype PdDvLn[48];          /* offset: 0x60 ( 96) */
         };
/*
        descriptors:    8
        structure size:     0x98 (152) bytes
        data offset:    0x20001cd8
        population:     50 objects (50 active, 0 deleted)
*/
```

5.3 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. A system administrator wishes to determine if a newly configured tape drive is correctly added to the ODM database. Which command would the administrator use?

   A. odmshow

   B. odmadd

   C. odmget

D. `odmcreate`

2. The ODM is located in:

   A. /etc/objrepos

   B. /usr/lib/objrepos

   C. /usr/share/lib/objrepos

   D. All of the above

5.3.1 Answers

The following are the answers to the previous questions:

1. C
2. D

5.4 Exercises

Provided here are some exercises you may wish to perform:

1. List the uses of the ODM.
2. Using the correct ODM facility, determine the format of the Predefined Device Database (PdDv).

Chapter 6. Storage Management, LVM, and File Systems

In this chapter, storage management, Logical Volume Management (LVM), and file system support issues are covered. The basic tasks that require understanding are broken down into separate sections.

6.1 Logical Volume Storage Concepts

The five basic logical storage concepts are: Physical volumes, volume groups, physical partitions, logical volumes, and logical partitions. The relationships among these concepts are provided in Figure 36.

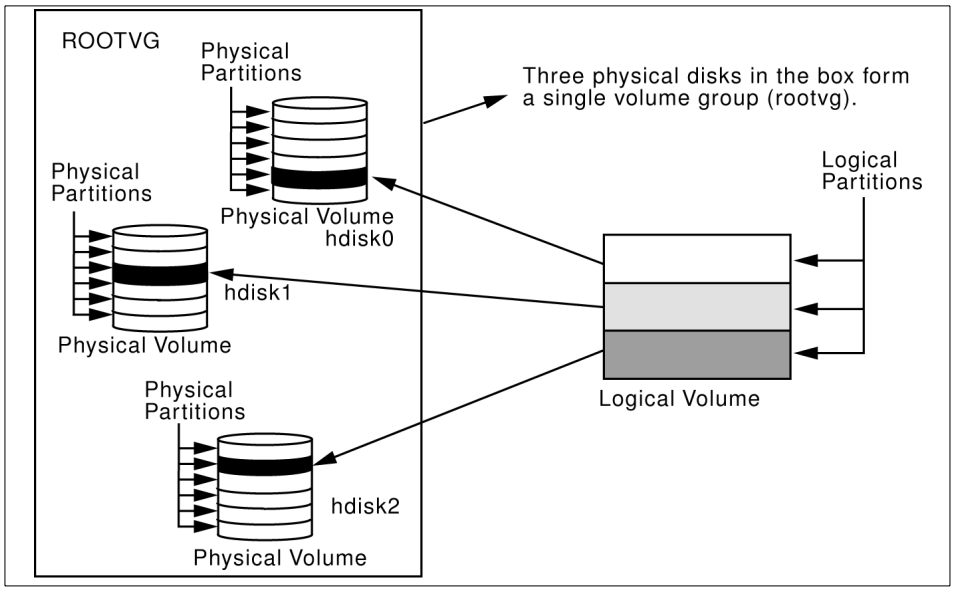

Figure 36. Relationship between Logical Storage Components

The following can be said regarding Figure 36:

- Each individual fixed-disk drive is called a physical volume (PV) and has a name (for example: hdisk0, hdisk1, or hdisk2).
- All physical volumes belong to one volume group (VG) named rootvg.
- All of the physical volumes in a volume group are divided into physical partitions (PPs) of the same size.
- Within each volume group, one or more logical volumes (LVs) are defined. Logical volumes are groups of information located on physical volumes.

Data on logical volumes appear as contiguous to the user but can be discontiguous on the physical volume.

- Each logical volume consists of one or more logical partitions (LPs). Each logical partition corresponds to at least one physical partition. If mirroring is specified for the logical volume, additional physical partitions are allocated to store the additional copies of each logical partition.
- Logical volumes can serve a number of system purposes (paging, for example), but each logical volume that holds ordinary systems, user data, or programs, contains a single journaled file system (JFS). Each JFS consists of a pool of page-size (4 KB) blocks. In AIX 4.1, a given file system can be defined as having a fragment size of less than 4 KB (512 bytes, 1 KB, 2 KB).

After installation, the system has one volume group (the rootvg volume group) consisting of a base set of logical volumes required to start the system and any others you specify to the installation script.

6.2 Logical Volume Manager

The set of operating system commands, library subroutines, and other tools that allow you to establish and control logical volume storage is called the Logical Volume Manager (LVM). The LVM controls disk resources by mapping data between a more simple and flexible logical view of storage space and the actual physical disks.

6.2.1 LVM Configuration Data

The data that describes the components of the LVM is not kept in one place. It is important to understand that this descriptive data on volume groups, logical volumes, and physical volumes is kept in several places.

6.2.1.1 Object Data Manager (ODM) Database

The ODM database is the place where most of the AIX V3 system configuration data is kept. The ODM database contains information about all configured physical volumes, volume groups, and logical volumes. This information mirrors the information found in the VGDA. For example, the process of importing a VGDA involves copying the VGDA data for the imported volume group into the ODM. When a volume group is exported, the data held in the ODM about that volume group is removed from the ODM database.

The ODM data also mirrors the information held in the Logical Volume Control Block.

6.2.1.2 Volume Group Descriptor Area (VGDA)

The VGDA, located at the beginning of each physical volume, contains information that describes all the logical volumes and all the physical volumes that belong to the volume group of which that physical volume is a member. The VGDA is updated by almost all the LVM commands. The VGDA makes each volume group self-describing. An AIX system can read the VGDA on a disk, and from that, the system can determine what physical volumes and logical volumes are part of this volume group.

Each disk contains at least one VGDA. This is important at vary on time. The time stamps in the VGDAs are used to determine which VGDAs correctly reflect the state of the volume group. VGDAs can get out of sync when, for example, a volume group of four disks has one disk failure. The VGDA on that disk cannot be updated while it is not operational. Therefore, you need a way to update this VGDA when the disk comes online, and this is what the vary on process will do.

The VGDA is allocated when the disk is assigned as a physical volume (with the command `mkdev`). This just reserves a space for the VGDA at the start of the disk. The actual volume group information is placed in the VGDA when the physical volume is assigned to a volume group (using the `mkvg` or `extendvg` commands). When a physical volume is removed from the volume group (using the `reducevg` command), the volume group information is removed from the VGDA.

6.2.1.3 Volume Group Status Area (VGSA)

The VGSA contains state information about physical partitions and physical volumes. For example, the VGSA knows if one physical volume in a volume group is unavailable.

Both the Volume Group Descriptor Area and the Volume Group Status Area have beginning and ending time stamps that are very important. These time stamps enable the LVM to identify the most recent copy of the VGDA and the VGSA at vary on time.

The LVM requires that the time stamps for the chosen VGDA be the same as those for the chosen VGSA.

6.2.1.4 Logical Volume Control Block (LVCB)

The LVCB is located at the start of every logical volume. It contains information about the logical volume and takes up a few hundred bytes.

The following example shows the use of `getlvcb` command to display the information held in the LVCB of logical volume hd2:

```
# getlvcb -TA hd2
AIX LVCB
intrapolicy = c
copies = 1
interpolicy = m
lvid = 00011187ca9acd3a.7
lvname = hd2
label = /usr
machine id = 111873000
number lps = 72
relocatable = y
strict = y
type = jfs
upperbound = 32
fs = log=/dev/hd8:mount=automatic:type=bootfs:vol=/usr:free=false
time created  = Tue Jul 27 13:38:45 1993
time modified = Tue Jul 27 10:58:14 1993
```

6.2.2 Disk Quorum

Each physical disk in a volume group has at least one VGDA/VGSA. The number of VGDAs contained on a single disk varies according to the number of disks in the volume group as shown in the following example:

Single PV in a volume group	Two VGDAs on one disk.
Two PVs in a volume group	Two VGDAs on the first disk, one VGDA on the second disk.
Three or more PVs in a volume group	One VGDA on each disk.

A quorum is a state in which 51 percent or more of the physical volumes in a volume group are accessible. A quorum is a vote of the number of Volume Group Descriptor Areas and Volume Group Status Areas (VGDA/VGSA) that are active. A quorum ensures data integrity in the event of a disk failure.

When a volume group is created onto a single disk, it initially has two VGDA/VGSA areas residing on the disk. If a volume group consists of two disks, one disk still has two VGDA/VGSA areas, but the other disk has one VGDA/VGSA. When the volume group is made up of three or more disks, then each disk is allocated just one VGDA/VGSA.

The Figure 37 shows that the quorum is lost when enough disks and their VGDA/VGSA areas are unreachable so that a 51% majority of VGDA/VGSA areas no longer exists.

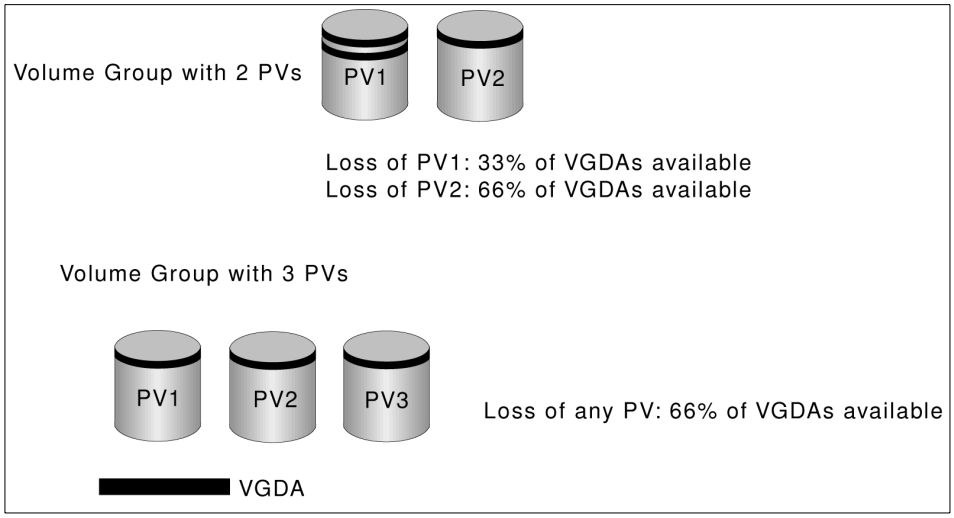

Figure 37. Disk Quorum

When a quorum is lost, the volume group varies itself off so that the disks are no longer accessible by the Logical Volume Manager (LVM). This prevents further disk I/O to that volume group so that data is not lost or assumed to be written when physical problems occur. Additionally, as a result of the vary off, the user is notified in the error log that a hardware error has occurred and service must be performed.

This has implications when you want to use disk mirroring in order to ensure high availability. In a two disk mirrored system, if the first disk fails, then you have lost 66 percent of your VGDAs, and the entire volume group becomes unavailable. This defeats the purpose of mirroring. For this reason, three or more (and generally an odd number) disk units provide a higher degree of availability and are highly recommended where mirroring is desired.

Note

There is the ability to turn off disk quorum protection on any volume group. Turning off quorum protection allows a volume group to remain online even when a quorum or majority of its VGDAs are not online. This would allow the volume group to remain online in the situation described previously. This capability provides for a less expensive mirroring solution but does carry the risk of data loss as, after a disk failure, data is accessible but no longer mirrored.

6.2.3 Disk Mirroring

Disk mirroring is the association of two or three physical partitions with each logical partition in a logical volume. When the data is written onto the logical volume, it is also written to all the physical partitions that are associated with the logical partition. Therefore, mirroring of data increases the availability of data.

AIX and the logical volume manager provide a disk mirroring facility at a logical volume level. If mirroring is established, this can be done when a logical volume is created.

The `mklv` command allows you to select one or two additional copies for each logical volume. Mirroring can also be added to an existing logical volume using the `mklvcopy` command.

The following mirroring factors can further improve the data availability:

- The number of copies of data: Three copies of the data are more reliable than keeping only two copies.
- Location of the copies: Allocating the copies of a logical partition on different physical volumes is more reliable than allocating the copies on the same physical volume. This is because one of the most common error modes for disk subsystems is the loss of an individual physical disk. Copies can also be located across different disk adapters to further enhance isolation from failures.

6.2.3.1 The mirrorvg Command

The `mirrorvg` command mirrors all the logical volumes on a given volume group. This same function may also be accomplished manually if you run the `mklvcopy` command for each individual logical volume in a volume group. As with `mklvcopy`, the target physical drives to be mirrored with data must already be members of the volume group. This command only applies to AIX Version 4.2.1 or later.

The following is the syntax for the `mirrovg` command:

```
mirrorvg [ -S  | -s ] [ -Q ] [ -c Copies] [ -m  ] VolumeGroup [
PhysicalVolume .. ]
```

By default, `mirrorvg` attempts to mirror the logical volumes onto any of the disks in a volume group. The `mirrorvg` command mirrors the logical volumes using the default settings of the logical volume being mirrored. If you wish to violate mirror strictness or affect the policy by which the mirror is created, you

must execute the mirroring of all logical volumes manually with the `mklvcopy` command.

Note

The `mirrorvg` command may take a significant amount of time before completing because of complex error checking, the number of logical volumes to mirror in a volume group, and the time to synchronize the new mirrored logical volumes.

Alternatively, you can also use the SMIT fast path command, `smitty mirrorvg`, to do the mirroring of volume groups.

The following examples show the use of the `mirrorvg` command:

- To triply mirror a volume group, run the following command:

  ```
  mirrorvg -c 3 workvg
  ```

  The logical partitions in the logical volumes held on workvg now have three copies.

- To get default mirroring of rootvg, run the following command.

  ```
  mirrorvg rootvg
  ```

  The rootvg volume group now has two copies of data.

  Note

  Problems may occur when you attempt to place a disk back into the original system if the disk is removed from a volume group, updated, and then returned. There is no way to control which copy of the data will be used to resynchronize the other copy.

  If any LVM information is changed while the disk is in your backup system, those changes will not be known to your primary system even if the backup is used to resync the primary disk. LVM changes include: Creating, removing, or expanding any file system, paging spaces, and other logical volume.

- To replace a failed disk drive in a mirrored volume group, run the following commands:

  ```
  unmirrorvg workvg hdisk7
  reducevg workvg hdisk7
  rmdev -l hdisk7 -d
  ```

  Replace the failed disk drive with a new one, and name it hdisk7 by executing the following commands:

```
extendvg workvg hdisk7
mirrorvg workvg
```

Note

By default in this example, mirrorvg will try to create two copies for the logical volumes in workvg. It will try to create the new mirrors onto the replaced disk drive. However, if the original system had been triply mirrored, there may be no new mirrors created onto hdisk7, as other copies may already exist for the logical volumes.

- The following command will sync the newly created mirrors:

  ```
  mirrorvg -S -c 3 workvg
  ```

  The -c flag specifies the minimum number of copies that each logical volume must have after the `mirrorvg` command finishes executing. The -S flag returns the `mirrorvg` command immediately and performs a background `syncvg` of the volume group. It will not be apparent when the mirrors are synced, but they will be immediately used by the system when ready.

- To create an exact mapped volume group, run the following command:

  ```
  mirrorvg -m datavg hdisk2 hdisk3
  ```

  The -m flag allows mirroring of logical volumes in the exact physical partition order that the original copy is ordered.

6.2.3.2 Rootvg Mirroring

When the rootvg mirroring has completed, the following three tasks must be performed.

- Run the `bosboot` command.

The `bosboot` command creates a boot file (boot image) from a RAM (Random Access Memory) disk file system and a kernel. The `bosboot` command is required to customize the bootrec of the newly mirrored drive.

- Run the `bootlist` command.

The `bosboot` command always saves device configuration data for disk. It does not update the list of boot devices in the NVRAM (nonvolatile random access memory). The NVRAM list can be modified by using the `bootlist` command.

- Reboot the system.

Finally, the default of the `mirrorvg` command is for the quorum to be turned off. To turn quorum off on a rootvg volume group, the system must be rebooted.

Note

Do not reboot the machine if the `bosboot` command has unsuccessfully created a boot disk. The problem should be resolved and the `bosboot` command run to successful completion. The `bosboot` command requires some space in the /tmp file system and the file system where the target image is to reside if there is such an image.

6.2.3.3 Non-rootvg Mirroring

When this volume group is mirrored, the quorum gets deactivated. For the deactivation of the quorum to take effect, all open logical volumes must be closed. Then vary off and vary on the volume group for the changes to take effect.

If the re-vary on of the volume group is not performed, although the mirroring will work correctly, no quorum changes will have taken effect.

6.2.3.4 Rootvg and Non-rootvg Mirroring

The system dump devices - primary(/dev/hd6) and secondary (/dev/sysdumpnull) - should not be mirrored. On some systems, the paging device and the dump device are the same device. However, most users want the paging device mirrored. When mirrorvg detects that a dump device and the paging device are the same, the logical volume will be mirrored automatically.

If mirrorvg detects that the dump and paging devices are different logical volumes, the paging device is automatically mirrored, but the dump logical volume is not. The dump device can be queried and modified with the `sysdumpdev` command.

6.3 Managing Physical Volumes

The following sections discuss adding a new disk drive, changing physical volume characteristics, and monitoring the physical volumes.

6.3.1 Configuration of Physical Volume

The following three methods can be used to configure a new disk drive. If the LVM will use this disk, it must also be made a physical volume.

6.3.1.1 Method 1

This method is used when it is possible to shut down and power off the system prior to attaching the disk.

When the system is booted after adding a disk drive, the `cfgmgr` command is run by the system during booting, which will automatically configure the disk. After boot-up is complete, log in as root, run `lspv`, and look for a new disk entry in the output as shown in the following example.

```
hdisk1  none                    none
```

or

```
hdisk1  00005264d21adb2e        none
```

The 16-digit number in the second column of the preceding example is the physical volume identifier (PVID).

If the output shows the new disk with a PVID, it can be used by the LVM for configuration. If the new disk does not have a PVID, then use the procedure described in 6.3.2, “Making an Available Disk a Physical Volume” on page 117 to allow the disk to be used by the LVM.

6.3.1.2 Method 2

This method may be used when it is not possible to shut down or power off the system prior to attaching the disk. Perform the following tasks:

1. Run `lspv` to list the physical disks already configured on the system as shown in the following example:

   ```
   # lspv
   hdisk0       000005265ac63976    rootvg
   ```

2. To configure all newly detected devices on the system (including the new disk) use the following command:

   ```
   cfgmgr
   ```

3. Run `lspv` again and look for a new disk entry in the output as shown in the following example:

   ```
   hdisk1    none                  none
   ```

   or

   ```
   hdisk1   00005264d21adb2e     none
   ```

Once you have determined the name of the newly configured disk, use the procedure described in 6.3.2, “Making an Available Disk a Physical Volume” on page 117 to allow the disk to be utilized by the Logical Volume Manager.

6.3.1.3 Method 3

This method may be used when it is not possible to shut down or power off the system prior to attaching the disk. This method requires the following information about the new disk:

- How the disk is attached (subclass).
- The type of the disk (type).
- Which system attachment the disk is connected to (parent name).
- The logical address of the disk (where connected).

Use the following command to configure the disk and ensure that it is available as a physical volume by using the `pv=yes` attribute.

```
mkdev -c disk -s subclass -t type -p parentname -w whereconnected -a
pv=yes
```

The `pv=yes` attribute makes the disk a physical volume and writes a boot record with a unique physical volume identifier onto the disk (if it does not already have one).

6.3.2 Making an Available Disk a Physical Volume

A new disk drive is usable only when assigned to a volume group. To be used by the LVM, a disk must be configured as a physical volume. The following command will change an available disk (hdisk1) to a physical volume by assigning a physical volume identifier (PVID) if it does not already have one.

```
chdev -l hdisk1 -a pv=yes
```

This command has no effect if the disk is already a physical volume.

6.3.3 Modifying Physical Volume Characteristics

This section discusses the two characteristics that can be changed for a physical volume to control the use of physical volumes using the `chpv` command.

6.3.3.1 Setting Allocation Permission for a Physical Volume

The allocation permission for a physical volume determines if physical partitions contained on this disk, which are not allocated to a logical volume yet, can be allocated for use by logical volumes. Setting the allocation permission defines whether or not the allocation of new physical partitions is permitted for the specified physical volume.

The following command is used to turn off the allocation permission for the physical volume hdisk1.

```
chpv -a n hdisk1
```

To turn the allocation permission back on, use the following command:

```
chpv -a y hdisk1
```

6.3.3.2 Setting the Availability of a Physical Volume

The availability of a physical volume defines whether any logical input/output operations can be performed to the specified physical volume. Physical volumes should be made unavailable when they are to be removed from the system or are lost due to failure.

The following command is used to set the state of a physical volume to unavailable.

```
chpv -v r pvname
```

This will quiesce all VGDA and VGSA copies on the physical volume, and the physical volume will not take part in future vary on quorum checking. Also, information about the specified volume will be removed from the VGDAs of the other physical volumes in that volume group.

The following command will make a physical volume available to the system.

```
chpv -v a pvname
```

> **Note**
>
> The `chpv` command uses space in the /tmp directory to store information while it is executing. If it fails, it could be due to lack of space in the /tmp directory. Create more space in that directory and try again.

6.3.4 Removing Physical Volumes

A physical volume must be unconfigured before it can be removed from the system. The following example shows how to unconfigure a physical volume (hdisk1) and change its state from available to defined using the `rmdev` command.

```
rmdev -l hdisk1
```

The definition of this physical volume will remain in the ODM. The -d flag removes the definition from the ODM.

6.3.5 Listing Information about Physical Volumes

A physical volume correctly installed on the system can be assigned to a volume group and can subsequently be used to hold file systems and logical volumes.

The information about free physical partitions and their availability within different sectors on the disk can be very useful. The following section will discuss using the `lspv` command to obtain such information as is pertinent to physical volumes.

6.3.5.1 Listing Physical Volumes on the System

The `lspv` command run without any flag will produce output that will identify the physical volumes by name that are known to the system as shown in the following example:

```
# lspv
hdisk0          00615147ce54a7ee    rootvg
hdisk1          00615147a877976a    rootvg
#
```

The `lsdev` command with option with the -C option and -c class will also list the physical volumes on the system along with the status of each physical volume as shown in the following example:

```
# lsdev -C -c disk
hdisk0 Available 40-58-00-0,0 16 Bit SCSI Disk Drive
hdisk1 Available 40-58-00-1,0 16 Bit SCSI Disk Drive
hdisk2 Available 20-68-L      SSA Logical Disk Drive
hdisk3 Available 20-68-L      SSA Logical Disk Drive
hdisk4 Available 20-68-L      SSA Logical Disk Drive
hdisk5 Available 20-68-L      SSA Logical Disk Drive
hdisk6 Available 20-68-L      SSA Logical Disk Drive
#
```

6.3.5.2 Listing Physical Volume Characteristics

The following example shows the use of the `lspv` command to retrieve more detailed information about a physical volume:

```
# lspv hdisk1
PHYSICAL VOLUME:    hdisk1                  VOLUME GROUP:     rootvg
PV IDENTIFIER:      00615147a877976a        VG IDENTIFIER     00615147b27f2b40
PV STATE:           active
STALE PARTITIONS:   0                       ALLOCATABLE:      yes
PP SIZE:            4 megabyte(s)           LOGICAL VOLUMES:  13
TOTAL PPs:          238 (952 megabytes)     VG DESCRIPTORS:   1
FREE PPs:           71 (284 megabytes)
USED PPs:           167 (668 megabytes)
FREE DISTRIBUTION:  48..02..00..00..21
USED DISTRIBUTION:  00..46..47..47..27
#
```

The left hand pair of columns holds information about the physical volume itself. The right hand pair displays information concerning the volume group of which the physical volume is a member.

The following are the meanings of various fields in the preceding example.

PHYSICAL VOLUME The name of the specified physical volume.

PV IDENTIFIER The physical volume identifier (unique to the system).

PV STATE The state of the physical volume. This defines whether or not the physical volume is available for logical input/output operations. It can be changed using the `chpv` command.

STALE PARTITIONS The number of stale partitions.

PP SIZE The size of a physical partition. This is a characteristic of the volume group and is set only at the creation of the volume group as an argument to the `mkvg` command. The default size is 4 MB.

TOTAL PPs The total number of physical partitions including both free and used partitions available on the physical volume.

FREE PPs The number of free partitions available on the physical volume.

USED PPs The number of used partitions on the physical volume.

FREE DISTRIBUTION This field summarizes the distribution of free physical partitions across the physical volume according to the sections of the physical volume on which they reside.

USED DISTRIBUTION Same as free distribution except that it displays the allocation of used physical partitions.

VOLUME GROUP The name of the volume group to which the physical volume is allocated.

VG IDENTIFIER The numerical identifier of the volume group to which the physical volume is allocated.

VG STATE State of the volume group. If the volume group is activated with the `varyonvg` command, the state is either active/complete (indicating all physical volumes are active) or active/partial (indicating

some physical volumes are not active). If the volume group is not activated with the `varyonvg` command, the state is inactive.

ALLOCATABLE Whether the system is permitted to allocate new physical partitions on this physical volume.

LOGICAL VOLUMES The number of the logical volumes in the volume group.

VG DESCRIPTORS The number of VGDAs for this volume group which reside on this particular physical volume.

6.3.5.3 Listing Logical Volume Allocation within a PV

The following example shows the `lspv` command with the -l option to list the physical volume hdisk1. The output shows the names of all the logical volumes on the physical volume, the number of physical and logical partitions allocated, the distribution across the physical volume, and the mount point if one exists.

```
# lspv -l hdisk1
hdisk1:
LV NAME               LPs   PPs   DISTRIBUTION          MOUNT POINT
rawlv                 1     1     01..00..00..00..00    N/A
hd4                   2     2     02..00..00..00..00    /
hd9var                1     1     01..00..00..00..00    /var
hd3                   8     8     01..00..07..00..00    /tmp
lv06                  5     5     00..05..00..00..00    /home2
lv07                  13    13    00..13..00..00..00    /backfs
rawlv1                2     2     00..02..00..00..00    N/A
copied                2     2     00..02..00..00..00    N/A
newlv                 1     1     00..01..00..00..00    N/A
fslv00                1     1     00..01..00..00..00    N/A
hd6                   1     1     00..01..00..00..00    N/A
mytest                1     1     00..01..00..00..00    N/A
#
```

6.3.5.4 Listing Physical Partition Allocation by PV Region

The example provided in Figure 38 shows how to retrieve more detailed information about the range of physical partitions allocated to a logical volume and the region of disk used for those partitions.

```
# lspv -p hdisk1
hdisk1:
PP RANGE  STATE   REGION        LV NAME             TYPE       MOUNT POINT
  1-2     used    outer edge    hd5                 boot       N/A
  3-19    free    outer edge
 20-30    used    outer edge    hd2                 jfs        /usr
 31-31    used    outer edge    hd4                 jfs        /
 32-103   used    outer edge    hd2                 jfs        /usr
104-143   used    outer middle  paging01            paging     N/A
144-170   used    outer middle  hd2                 jfs        /usr
171-173   free    outer middle
174-174   used    outer middle  hd6                 paging     N/A
175-179   free    outer middle
180-184   used    outer middle  paging02            paging     N/A
185-192   used    outer middle  hd1                 jfs        /home
193-195   used    outer middle  lv01                jfs        /var/dce
196-205   used    outer middle  lv02                jfs        /var/dce/adm/dfs/
cache
206-206   used    outer middle  hd2                 jfs        /usr
207-207   used    center        hd8                 jfslog     N/A
208-208   used    center        hd4                 jfs        /
209-217   used    center        hd2                 jfs        /usr
218-218   used    center        hd9var              jfs        /var
219-221   used    center        hd3                 jfs        /tmp
222-222   used    center        hd1                 jfs        /home
223-285   used    center        hd2                 jfs        /usr
286-286   used    center        hd3                 jfs        /tmp
287-309   used    center        hd2                 jfs        /usr
310-412   used    inner middle  hd2                 jfs        /usr
413-447   used    inner edge    hd6                 paging     N/A
448-515   free    inner edge
# 
```

Figure 38. Status and Characteristics of hdisk1 by Physical Partitions

The following is the description of the fields shown in the preceding figure.

PP RANGE The range of physical partitions for which the current row of data applies.

STATE Whether or not the partitions have been allocated. Value can be either used or free.

REGION Region of the disk within which the partitions are located.

LV NAME Name of the logical volume to which the partitions in question have been allocated.

TYPE Type of file system residing on the logical volume.

MOUNT POINT Mount point of the file system if applicable.

6.3.5.5 Listing Physical Partition Allocation Table

To determine the degree of contiguity of data on the system in order to improve the I/O performance of a logical volume, you can use the `lspv` command with the -M option as shown in Figure 39. You may decide to reorganize the system after analyzing the output.

```
# lspv -M hdisk0
hdisk0:1-17
hdisk0:18       lv03:1
hdisk0:19       lv03:2
hdisk0:20       lv03:3
hdisk0:21       lv03:4
hdisk0:22-33
hdisk0:34       paging00:1
hdisk0:35       paging00:2
hdisk0:36       paging00:3
hdisk0:37       paging00:4
hdisk0:38       paging00:5
hdisk0:39       paging00:6
hdisk0:40       paging00:7
hdisk0:41       paging00:8
hdisk0:42       paging00:9
hdisk0:43       paging00:10
hdisk0:44       paging00:11
hdisk0:45       paging00:12
hdisk0:46       paging00:13
hdisk0:47       paging00:14
hdisk0:48       paging00:15
hdisk0:49       paging00:16
hdisk0:50       paging00:17
hdisk0:51       paging00:18
hdisk0:52       paging00:19
hdisk0:53       paging00:20
hdisk0:54       paging00:21
hdisk0:55       paging00:22
hdisk0:56       paging00:23
hdisk0:57       paging00:24
hdisk0:58-81
# 
```

Figure 39. Physical Partition Allocation by Disk Region

The first column indicates the physical partition (if a group of contiguous partitions are free, it will indicate a range of partitions) for a particular hard disk. The second column indicates which logical partition of which logical volume is associated with that physical partition.

6.3.5.6 Migrating the Contents of a Physical Volume

The physical partitions belonging to one or more specified logical volumes can be moved from one physical volume to one or more other physical volumes within a volume group using the `migratepv` command.

Note

The `migratepv` command cannot move data between different volume groups as shown in Figure 40. See 6.5.5, “Copying a Logical Volume” on page 146 for examples on how to move data between volume groups.

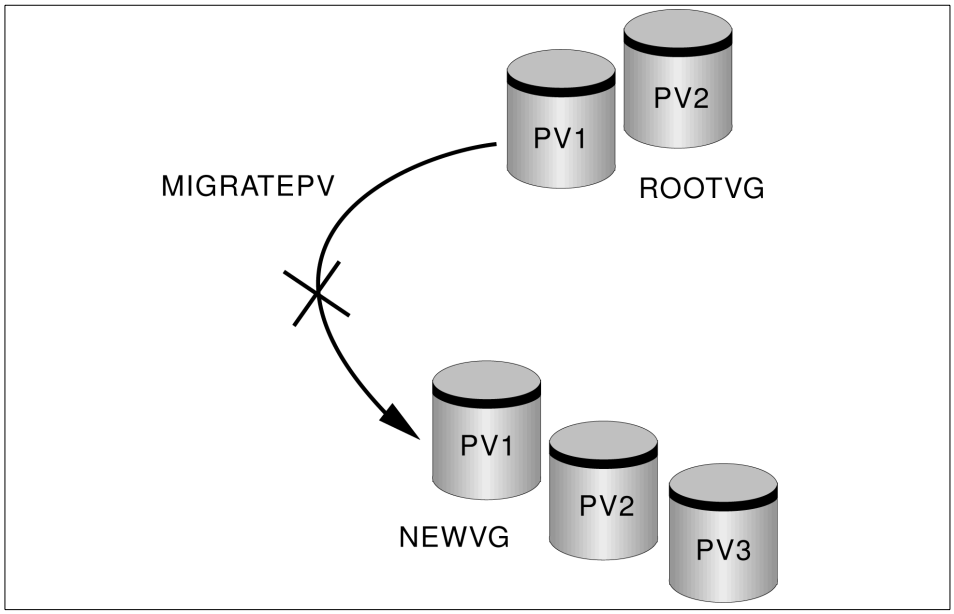

Figure 40. migratepv Does Not Work Across Volume Groups

The following procedure describes how to move the data from a failing disk before it is removed for repair or replacement.

1. Determine which disks are in the volume group. Make sure that the source and destination physical volumes are in the same volume group. If the source and destination physical volumes are in the same volume group, proceed to step 3.

```
# lsvg -p rootvg
rootvg:
  PV_NAME    PV STATE   TOTAL PPs   FREE PPs   FREE DISTRIBUTION
  hdisk0     active     159         0          00..00..00..00..00
```

2. If you are planning to migrate to a new disk, such as when you have a failing disk, perform the following steps:

   a. Make sure the disk is available by entering the following:

```
# lsdev -Cc disk
hdisk0  Available  00-08-00-30  670 MB  SCSI  Disk Drive
hdisk1  Available  00-08-00-20  857 MB  SCSI  Disk Drive
```

b. If the disk is listed and in the available state, make sure it does not belong to another volume group using the following command. (In the following example, `hdisk1` can be used as a destination disk.)

```
# lspv
hdisk0     0000078752249812   rootvg
hdisk1     000000234ac56e9e   none
```

c. If the disk is not listed or is not available, you need to check or install the disk.

d. Add the new disk to the volume group using the command:

```
extendvg VGName hdiskNumber
```

3. Make sure that you have enough room on the target disk for the source that you want to move.

a. Determine the number of physical partitions on the source disk by using the following command. (`SourceDiskNumber` will be of the form hdiskNumber.)

```
lspv SourceDiskNumber | grep "USED PPs"
```

The output will look similar to the following:

```
USED PPs:      159 (636 megabytes)
```

In this example, you would need 159 free PPs on the destination disk to successfully complete the migration.

b. Determine the number of free physical partitions on the destination disk or disks using the following command for each destination disk (`DestinationDiskNumber` will be of the form hdiskNumber).

```
lspv DestinationDiskNumber | grep "FREE PPs"
```

Add the free PPs from all of the destination disks. If the sum is larger than the number of USED PPs from step 3, you will have enough space for the migration.

4. Follow this step only if you are migrating data from a disk in the rootvg volume group. If you are migrating data from a disk in a user-defined volume group, proceed to step 5.

Check to see if the boot logical volume (`hd5`) is on the source disk:

```
lspv -l SourceDiskNumber | grep hd5
```

If you get no output, the boot logical volume is not located on the source disk. Continue to step 5.

If you get output similar to the following:

```
hd5             2   2   02..00..00..00..00   /blv
```

then run the following command:

```
migratepv -l hd5 SourceDiskNumber DestinationDiskNumber
```

Note

- The `migratepv` command is not allowed if the volume group is varied on in a concurrent mode.
- The `migratepv` command cannot migrate striped logical volumes. If this is the case, to move data from one physical volume to another, use the `cplv` command to copy the data, and then use the `rmlv` command to remove the old copy.
- You must either have root user authority or be a member of the system group to run the `migratepv` command.

Next, you will get a message warning you to perform the `bosboot` command on the destination disk.

Note

When the boot logical volume is migrated from a physical volume, the boot record on the source should be cleared. Failure to clear this record may result in a system hang. When you run the `bosboot` command, you must also run: `mkboot -c`

Run the `mkboot -c` command to clear the boot record on the source. Do the following on pre-AIX 4.2 systems:

```
bosboot -a -d /dev/DestinationDiskNumber
```

then:

```
bootlist -m normal DestinationDiskNumber
```

then:

```
mkboot -c -d /dev/SourceDiskNumber
```

5. Executing the SMIT fast path command `smitty migratepv` to migrate the data will show a screen similar to Figure 41 on page 127.

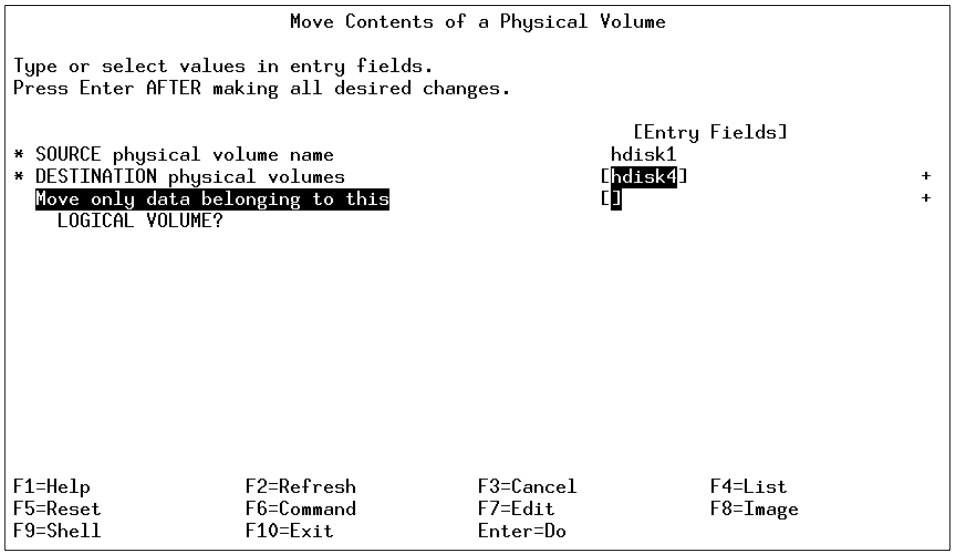

Figure 41. smitty migratepv Command

6. List the physical volumes by pressing PF4, and select the source physical volume you examined previously.
7. Go to the DESTINATION physical volume field. If you accept the default, all the physical volumes in the volume group are available for the transfer. Otherwise, select one or more disks with adequate space for the partitions you will be moving (from step 4).
8. If you wish, go to the Move only data belonging to this LOGICAL VOLUME field and list and select a logical volume. You will move only the physical partitions allocated to the logical volume specified that are located on the physical volume selected as the source physical volume.
9. Press **Enter** to move the physical partitions.
10. To remove the source disk from the volume group, such as when it is failing, enter the following command:

    ```
    reducevg VGNname SourceDiskNumber
    ```

11. Before physically removing the source disk from the system, such as when it is failing, enter the following command:

    ```
    rmdev -l SourceDiskNumber -d
    ```

The following are a few more examples of using the `migratepv` command.

- Use the following command to move physical partitions from `hdisk1` to `hdisk6` and `hdisk7`. All physical volumes are in one volume group.

  ```
  migratepv hdisk1 hdisk6 hdisk7
  ```

- Use the following command to move physical partitions in logical volume `lv02` from `hdisk1` to `hdisk6`.

  ```
  migratepv -l lv02 hdisk1 hdisk6
  ```

6.4 Managing Volume Groups

This section discusses the functions that can be performed on volume groups. As with physical volumes, volume groups can be created and removed, and their characteristics can be modified. Additional functions, such as activating and deactivating volume groups, can also be performed.

6.4.1 Adding a Volume Group

Before a new volume group can be added to the system, one or more physical volumes, not used in other volume groups and in an available state, must exist on the system.

It is important to decide upon certain information, such as the volume group name and the physical volumes to use, prior to adding a volume group.

New volume groups can be added to the system by using the `mkvg` command or by using SMIT. Of all the characteristics set at creation time of the volume group, the following are the most important:

- The volume group names must be unique on the system.
- The names of all physical volumes to be used in the new volume group.
- The maximum number of physical volumes that can exist in the volume group.
- The physical partition size for the volume group.
- The flag to activate the volume group automatically at each system restart.

The following example shows the use of the `mkvg` command to create a volume group, `myvg`, using the physical volumes `hdisk1` and `hdisk5`, with a physical partition size of 4 KB. The volume group is limited to a maximum of 10 physical volumes.

```
mkvg -y myvg -d 10 -s 8 hdisk1 hdisk5
```

Alternatively, you can use the SMIT fast path command `smitty mkvg` to obtain the screen shown in Figure 42 and enter the characteristics of the volume group to be created in the fields.

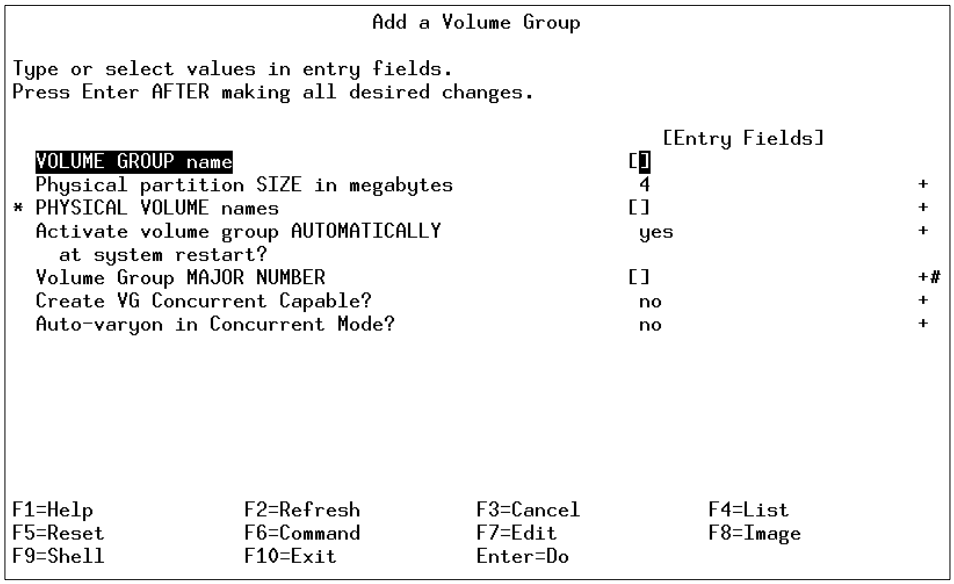

Figure 42. smitty mkvg Command

The `smitty mkvg` command will automatically activate the volume group by calling the `varyonvg` command. Moreover, the SMIT command limits the followings function as compared to executing from the command line.

- `smitty mkvg` does not provide the -d flag to set the maximum number of physical volumes. It uses a default value of 32.
- `smitty mkvg` does not provide the -m flag to set the maximum size of the physical volume. This flag will determine how many physical partitions are used. It uses a set value of 1016 partitions.
- `smitty mkvg` always uses the -f flag to force the creation of the volume group.

Note

For a new volume group to be successfully added to the system using the `mkvg` command, the root file system should have about 2 MB of free space. Check this using the `df` command. This free space is required because a file is written in the directory /etc/vg each time a new volume group is added.

6.4.2 Modifying Volume Group Characteristics

The following sections discuss the tasks required to modify a volume group's characteristics.

6.4.2.1 Modifying Volume Group Activation Characteristics

The following command allows the volume group, `newvg`, to be varied on automatically each time a system is restarted.

```
chvg -ay newvg
```

The following command will turn off the automatic varying on of a volume group at the system restart.

```
chvg -an newvg
```

6.4.2.2 Unlocking a Volume Group

A volume group can become locked when an LVM command terminates abnormally due to a system crash while an LVM operation was being performed on the system.

In AIX Version 4, it is now also possible to unlock a volume group. The following example shows the command to unlock a volume group (`newvg`).

```
chvg -u newvg
```

6.4.2.3 Adding a Physical Volume

It may be necessary to increase the free space available in a volume group so that existing file systems and logical volumes within the volume group can be extended, or new ones can be added. To do this requires additional physical volumes be made available within the volume group.

It is possible to add physical volumes to a volume group up to the maximum specified at creation time. A physical volume can be added using the `extendvg` command. The following example shows the command to add the physical volume `hdisk3` to volume group `newvg`.

```
extendvg newvg hdisk3
```

Note

The `extendvg` command will fail if the physical volume being added already belongs to a varied on volume group on the current system. Also, if the physical volume being added belongs to a volume group that is currently not varied on, the user will be asked to confirm whether or not to continue.

Alternatively, you can use the SMIT fast path command `smitty vgsc` and select **Add a Physical Volume to a Volume Group**.

6.4.2.4 Removing a Physical Volume

The volume group must be varied on before it can be reduced. The following example shows how to remove a physical volume `hdisk3` from a volume group, `myvg`.

```
reducevg myvg hdisk3
```

Alternatively, you can use the SMIT fast path command `smitty reducevg` to remove a physical volume from a volume group.

Note

The `reducevg` command provides the -d and -f flags.

- The -d flag can be dangerous because it automatically deletes all logical volume data on the physical volume before removing the physical volume from the volume group. If a logical volume spans multiple physical volumes, the removal of any of those physical volumes may jeopardize the integrity of the entire logical volume.
- The -f flag makes the -d flag even more dangerous by suppressing interaction with a user requesting confirmation that the logical volume should be deleted.

If the logical volumes on the physical volume specified to be removed also span other physical volumes in the volume group, the removal operation may destroy the integrity of those logical volumes regardless of the physical volume on which they reside.

When you remove all physical volumes in a volume group, the volume group itself is also removed.

6.4.2.5 Removing a Physical Volume Reference

Sometimes a disk is removed from the system without first running `reducevg VolumeGroup PhysicalVolume`. The VGDA still has the removed disk's reference, but the physical volume name no longer exists or has been reassigned. To remove references to the disk that has been removed, you can still use the `reducevg` command using the PVID of the physical volume removed. The following command will remove the reference of a physical volume (with PVID of 000005265ac63976) from the volume group newvg.

```
reducevg VolumeGroup 000005265ac63976
```

6.4.3 Importing and Exporting a Volume Group

There may be times when a volume group needs to be moved from one RISC System/6000 system to another, so that logical volume and file system data in the volume group can be accessed directly on the target system.

To remove the system definition of a volume group from the ODM database, the volume group needs to be exported using the `exportvg` command. This command will not remove any user data in the volume group but will only remove its definition from the ODM database.

Similarly, when a volume group is moved, the target system needs to add the definition of the new volume group. This can be achieved by importing the volume group by using the `importvg` command, which will add an entry to the ODM database.

The following example shows the export of a volume group `myvg`.

```
exportvg myvg
```

And, the following example shows the import of a volume group `myvg`.

```
importvg myvg hdiskx
```

You can also use the SMIT fast path commands, `smitty exportvg` or `smitty importvg`, to export or import a volume group.

If the specified volume group name is already in use, the `importvg` command will fail with an appropriate error message since duplicate volume group names are not allowed. In this instance, the command can be rerun with a unique volume group name specified. The command can also be rerun without the -y flag or the volume group name, which gives the imported volume group a unique system default name.

It is also possible that some logical volume names may also conflict with those already on the system. The `importvg` command will automatically reassign these with system default names. The important thing to remember when moving volume groups from system to system is that the `exportvg` command is always run on the source system prior to importing the volume group to the target system. Consider that a volume group is imported on system Y without actually performing an `exportvg` on system X. If system Y makes a change to the volume group, such as removing a physical volume from the volume group, and the volume group is imported back onto system

X, the ODM database on system X will not be consistent with the changed information for this volume group.

However, it is worth noting that a volume group can be moved to another system without first being exported on the source system.

Note

- The `importvg` command changes the name of an imported logical volume if there currently is a logical volume with the same name already on the system. An error message is printed to standard error if an imported logical volume is renamed. The `importvg` command also creates file mount points and entries in /etc/filesystems if possible (if there are no conflicts).
- A volume group that has a paging space volume on it cannot be exported while the paging space is active. Before exporting a volume group with an active paging space, ensure that the paging space is not activated automatically at system initialization by running the following command:

  ```
  chps -a n paging_space_name
  ```

  Then, reboot the system so that the paging space is inactive.
- If you do not activate the volume group through `smitty importvg`, you must run the `varyonvg` command to enable access to the file systems and logical volumes.
- If you imported a volume group that contains file systems, or if you activated the volume group through `smitty importvg`, it is highly recommended that you run the `fsck` command before you mount the file systems. If you are moving the volume group to another system, be sure to unconfigure the disks before moving them.
- The `smitty exportvg` command deletes references to file systems in /etc/filesystems, but it leaves the mount points on the system.

6.4.4 Varying On and Varying Off a Volume Group

Once a volume group exists, it can be made available for use for system administrative activities using the `varyonvg` command. This process involves the following steps:

1. Each VGDA on each physical volume in a volume group is read.
2. The header and trailer time stamps within each VGDA are read. These time stamps must match for a VGDA to be valid.

3. If a majority of VGDAs (called the quorum) are valid, then the vary on process proceeds. If they are not, then the vary on fails.
4. The system will take the most recent VGDA (the one with the latest time stamp) and write it over all other VGDAs so they all match.
5. The `syncvg` command is run to resynchronize any stale partition present (in the case where mirroring is in use).

The `varyonvg` command has the following options that can be used to overcome damage to the volume group structure or give status information.

- The -f flag can be used to force a volume group to be varied on even when inconsistencies are detected. These inconsistencies are generally differences between the configuration data for each volume group held in the ODM database and VGDA.
- The -n flag will suppress the invocation of the `syncvg` command at vary on time. When a volume group is varied on, and stale partitions are detected, the vary on process will invoke the `syncvg` command to synchronize the stale partitions. This option is of value when you wish to carefully recover a volume group and you want to ensure that you do not accidentally write bad mirrored copies of data over good copies.
- The -s flag allows a volume group to be varied on in the maintenance or system management modes. Logical volume commands can operate on the volume group, but no logical volume can be opened for input or output.

The following example shows the command to activate a volume group, newvg.

```
varyonvg newvg
```

You can also use the SMIT fast path command, `smitty varyonvg`, to obtain output similar to what is presented in Figure 43. Enter the name of volume group to be varied on along with all the options.

```
                          Activate a Volume Group

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

                                                      [Entry Fields]
* VOLUME GROUP name                                  [ ]                +
  RESYNCHRONIZE stale physical partitions?            yes               +
  Activate volume group in SYSTEM                     no                +
    MANAGEMENT mode?
  FORCE activation of the volume group?               no                +
   Warning--this may cause loss of data
   integrity.
  Varyon VG in Concurrent Mode?                       no                +

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

Figure 43. smitty varyonvg Command

The `varyoffvg` command will deactivate a volume group and its associated logical volumes. This requires that the logical volumes be closed, which requires that file systems associated with logical volumes be unmounted. The `varyoffvg` command also allows the use of the -s flag to move the volume group from being active to being in the maintenance or systems management mode.

Note

In AIX Version 4, when a volume group is imported, it is automatically varied on; whereas, in AIX Version 3, the volume group has to be varied on separately.

The following example shows the command to deactivate a volume group, myvg.

```
varyoffvg myvg
```

You can also use the SMIT fast path command, `smitty varyoffvg`, which will show a screen as is shown in Figure 44 on page 136. You can enter the name of volume group to be varied off, and you can also put the volume group into system management mode.

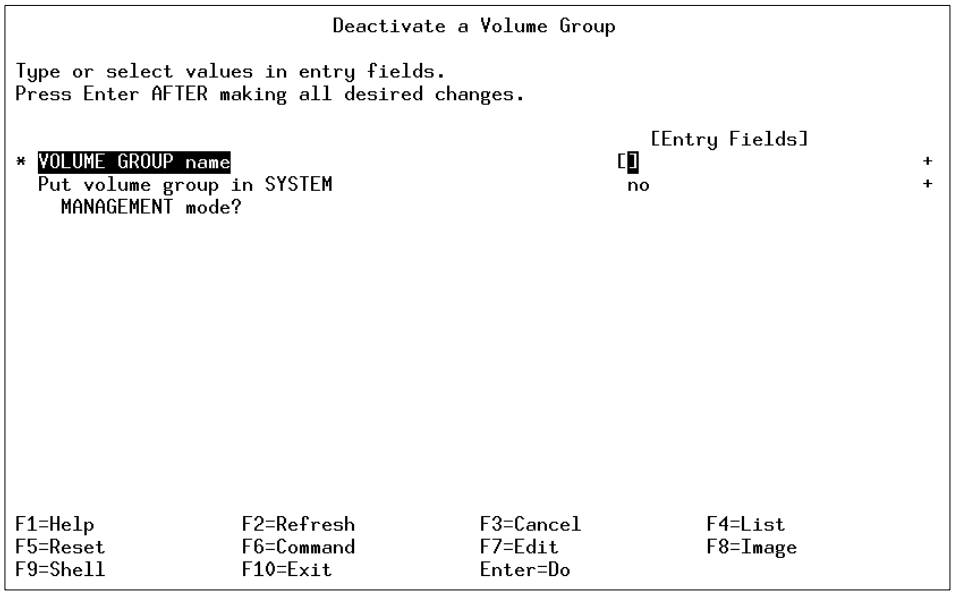

Figure 44. smitty varyoffvg Command

6.4.5 Monitoring a Volume Group

The `lsvg` command interrogates the ODM database for all volume groups currently known to the system. The following are a few examples showing the use of the `lsvg` command to monitor volume groups.

6.4.5.1 Listing the Volume Groups

The following example shows the use of the `lsvg` command without any flag to list all the volume groups known to the system.

```
# lsvg
rootvg
altinst_rootvg
datavg
testvg
#
```

The following example shows how to list the volume groups that are currently active (varied on).

```
# lsvg -o
testvg
datavg
rootvg
```

6.4.5.2 Listing the Characteristics of a Volume Group

The example in Figure 45 shows the command to list detailed information and status about volume group characteristics.

```
# lsvg rootvg
VOLUME GROUP:   rootvg                  VG IDENTIFIER:  00615151e5394126
VG STATE:       active                  PP SIZE:        4 megabyte(s)
VG PERMISSION:  read/write              TOTAL PPs:      596 (2384 megabytes)
MAX LVs:        256                     FREE PPs:       146 (584 megabytes)
LVs:            14                      USED PPs:       450 (1800 megabytes)
OPEN LVs:       13                      QUORUM:         2
TOTAL PVs:      2                       VG DESCRIPTORS: 3
STALE PVs:      0                       STALE PPs:      0
ACTIVE PVs:     2                       AUTO ON:        yes
MAX PPs per PV: 1016                    MAX PVs:        32
# 
```

Figure 45. lsvg rootvg Command

6.4.5.3 Listing the Logical Volumes in a Volume Group

The example in Figure 46 shows the command used to display the names, characteristics, and status of all the logical volumes in the volume group rootvg.

```
# lsvg -l rootvg
rootvg:
LV NAME             TYPE       LPs   PPs   PVs  LV STATE      MOUNT POINT
hd5                 boot       2     2     1    closed/syncd  N/A
hd6                 paging     36    36    1    open/syncd    N/A
hd8                 jfslog     1     1     1    open/syncd    N/A
hd4                 jfs        2     2     1    open/syncd    /
hd2                 jfs        309   309   1    open/syncd    /usr
hd9var              jfs        1     1     1    open/syncd    /var
hd3                 jfs        4     4     1    open/syncd    /tmp
hd1                 jfs        9     9     1    open/syncd    /home
paging00            paging     24    24    1    open/syncd    N/A
paging01            paging     40    40    1    open/syncd    N/A
lv01                jfs        3     3     1    open/syncd    /var/dce
lv02                jfs        10    10    1    open/syncd    /var/dce/adm/dfs/c
lv03                jfs        4     4     1    open/syncd    /usr/vice/cache
paging02            paging     5     5     1    open/syncd    N/A
# 
```

Figure 46. lsvg -l rootvg Command

6.4.5.4 List the Physical Volume Status within a Volume Group

The example shown in Figure 47 on page 138 shows the use of the `lsvg` command with the -p flag to display a list of physical volumes contained in a volume group, as well as some status information including physical partition

allocation. This form of the `lsvg` command is useful for summarizing the concentrations of free space on the system.

```
# lsvg -p rootvg
rootvg:
PV_NAME           PV STATE    TOTAL PPs   FREE PPs    FREE DISTRIBUTION
hdisk1            active      515         93          17..08..00..00..68
hdisk0            active      81          53          17..12..00..08..16
# 
```

Figure 47. lsvg -p vgname Command

The following is the description of the various fields shown in the preceding example.

PV_NAME The name of the physical volume.

PV STATE Whether or not this physical volume is active.

TOTAL PPs The total number of physical partitions on this physical volume.

FREE PPs The total number of unused physical partitions on this physical volume.

FREE DISTRIBUTION The location of the free physical partitions on the physical volumes. There are five columns, one for each disk region, in the following order: Outside edge, Outside middle, Center, Inside middle, Inside edge.

6.4.6 Reorganizing a Volume Group

The `reorgvg` command is used to reorganize the physical partition allocation for a volume group according to the allocation characteristics of each logical volume.

The following is the syntax of the `reorgvg` command:

```
reorgvg [ -i ] VolumeGroup [ LogicalVolume ... ]
```

The volume group must be varied on and must have free partitions before you can use the `reorgvg` command. The relocatable flag of each logical volume must be set to y using the `chlv -r` command for the reorganization to take effect; otherwise, the logical volume is ignored.

Note

1. The `reorgvg` command does not reorganize the placement of allocated physical partitions for any striped logical volumes.
2. At least one free physical partition must exist on the specified volume group for the `reorgvg` command to run successfully.
3. In AIX Version 4.2, or later, if you enter the `reorgvg` command with the volume group name and no other arguments, it will only reorganize the first logical volume in the volume group. The first logical volume is the one listed by the `lsvg -l VolumeName` command.

You can also use the SMIT fast path command, `smitty reorgvg`, to do the same task. See Table 24 for details on a flag for the `reorgvg` command.

Table 24. reorgvg Command Flags

Flag	Description
-i	Specifies physical volume names read from standard input. Only the partitions on these physical volumes are organized.

- The following command reorganizes the logical volumes lv03, lv04, and lv07 on volume group vg02.

  ```
  reorgvg vg02 lv03 lv04 lv07
  ```

  Only the listed logical volumes are reorganized on vg02.

- The following example shows how to reorganize the partitions located on physical volumes `hdisk04` and `hdisk06` that belong to the logical volumes `lv203` and `lv205`.

  ```
  echo "hdisk04 hdisk06" | reorgvg -i vg02 lv203 lv205
  ```

  Only the partitions located on physical volumes `hdisk04` and `hdisk06` of volume group `vg02`, which belong to the logical volumes `lv203` and `lv205`, are reorganized.

6.4.7 Synchronizing a Volume Group

The `syncvg` command is used to synchronize logical volume copies that are not current (stale).

The following is the syntax of `syncvg` command:

```
syncvg [ -f ] [ -i ] [ -H ] [ -P NumParallelLps ] { -l | -p | -v }
Name ...
```

The syncvg command synchronizes the physical partitions, which are copies of the original physical partition that are not current. The syncvg command can be used with logical volumes, physical volumes, or volume groups, with the Name parameter representing the logical volume name, physical volume name, or volume group name. The synchronization process can be time consuming depending on the hardware characteristics and the amount of data.

When the -f flag is used, an uncorrupted physical copy is chosen and propagated to all other copies of the logical partition whether or not they are stale.

Unless disabled, the copies within a volume group are synchronized automatically when the volume group is activated by the varyonvg command. The commonly used flags with the syncvg command are shown in Table 25.

Table 25. Key Flags for the syncvg Command

Flag	Description
-p	Specifies that the Name parameter represents a physical volume device name.
-v	Specifies that the Name parameter represents a volume group device name.

The following examples show the use of the syncvg command.

- To synchronize the copies on physical volumes hdisk04 and hdisk05, run the following command:

```
syncvg -p hdisk04 hdisk05
```

- To synchronize the copies on volume groups vg04 and vg05, run the following command:

```
syncvg -v vg04 vg05
```

6.5 Managing Logical Volumes

Physical volumes and volume groups are normally not addressed directly by users and applications to access data, and they cannot be manipulated to provide disk space for use by users and applications. However, logical volumes provide the mechanism to make disk space available for use, giving users and applications the ability to access data stored on them.

When you create a logical volume, you specify the number of logical partitions for the logical volume. A logical partition maps to one, two, or three

physical partitions depending on the number of copies of your data you want to maintain. For example, you can specify a logical volume to be mirrored and have more than one copy as shown in Figure 48. One copy of the logical volume (the default) indicates that there is a direct mapping of one logical partition to one physical partition.

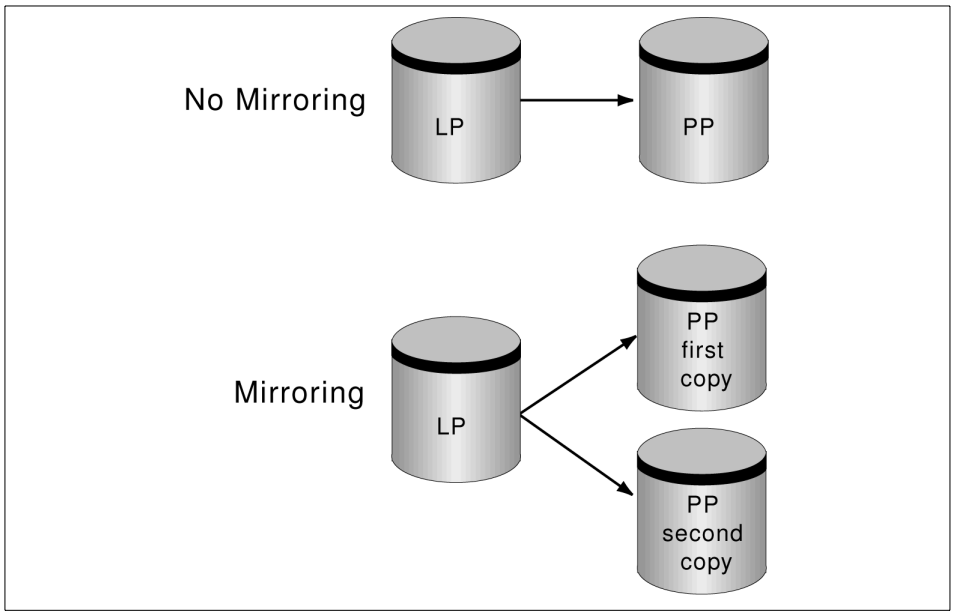

Figure 48. Mapping of LP to PP for Mirrored and Unmirrored Data

The management of logical volumes is, therefore, the management of disk space that is available for use. This section will review the functions that can be performed by users on logical volumes.

6.5.1 Adding a Logical Volume

You can create additional logical volumes with the `mklv` command. This command allows you to specify the name of the logical volume and define its characteristics including the number of the logical partitions to allocate for it. The default maximum size for a logical volume at creation is 128 logical partitions.

6.5.1.1 Creating a Logical Volume Using Command Line

The `mklv` command is used to create a new logical volume. The following is the syntax of the `mklv` command, and the most commonly used flags are shown in Table 26.

```
mklv [ -a Position ] [ -b BadBlocks ] [ -c Copies ] [ -d Schedule ] [ -e
Range ] [ -i ] [ -L Label ] [ -m MapFile ] [ -r Relocate ] [ -s Strict ] [
-t Type ] [ -u UpperBound ] [ -v Verify ] [ -w MirrorWriteConsistency ] [ -x
Maximum ] [ -y NewLogicalVolume | -Y Prefix ] [ -S StripeSize ] [ -U Userid
] [ -G Groupid ] [-P Modes ] VolumeGroup Number [ PhysicalVolume ... ]
```

Table 26. mklv Command Flags

Flag	Description
-c copies	Sets the number of physical partitions allocated for each logical partition. The copies variable can be set to a value from 1 to 3; the default is 1.
-i	Reads the PhysicalVolume parameter from standard input. Use the -i flag only when PhysicalVolume is entered through standard input.
-L	Sets the logical volume label. The default label is None. The maximum size of the label file is 127 characters. If the logical volume is going to be used as a journaled file system (JFS), then the JFS will use this field to store the mount point of the file system on that logical volume for future reference.
-P Modes	Specifies permissions (file modes) for the logical volume special file.
-t Type	Sets the logical volume type. The standard types are JFS (file systems), JFSLOG (journal file system logs), and paging (paging spaces), but a user can define other logical volume types with this flag. You cannot create a logical volume of type boot. The default is JFS. If a log is manually created for a file system, the user must run the `logform` command to clean out the new JFSLOG before the log can be used. Use the following command to format the logical volume logdev. `logform /dev/logdev` where `/dev/logdev` is the absolute path to the logical volume.
-y NewLogicalVolume	Specifies the logical volume name to use instead of using a system-generated name. Logical volume names must be unique names system-wide and can range from 1 to 15 characters. If the volume group is varied on in concurrent mode, the new name should be unique across all the concurrent nodes the volume group is varied on. The name cannot begin with a prefix already defined in the PdDv class in the Device Configuration Database for other devices.

The following example shows the use of `mklv` command to create a new logical volume, newlv. This will create a logical volume called newlv in the rootvg, and it will have 10 logical partitions, and each logical partition consists of two physical partitions.

```
mklv -y newlv -c 2 rootvg 10
```

6.5.1.2 Creating a Logical Volume Using SMIT

You can use the following SMIT dialog to create a logical volume.

1. Run the command: `smitty mklv`
2. Press **F4** to get a list of all the volume groups that are defined in the system. A screen similar to Figure 49 will be shown:

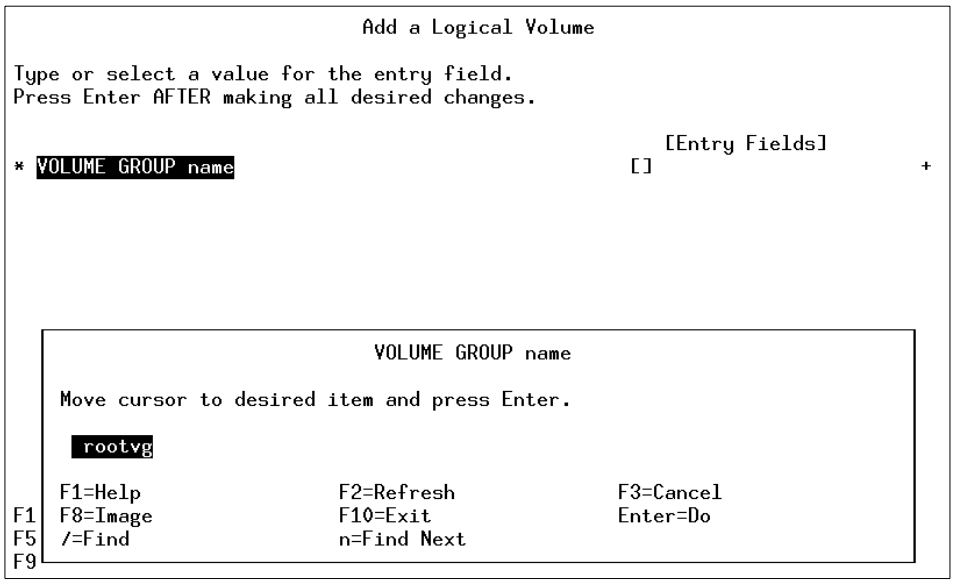

Figure 49. mklv - Step 1

3. Use the arrow keys to select the volume group in which you want to create your new logical volume and press **Enter**. A screen similar to Figure 50 will be shown:

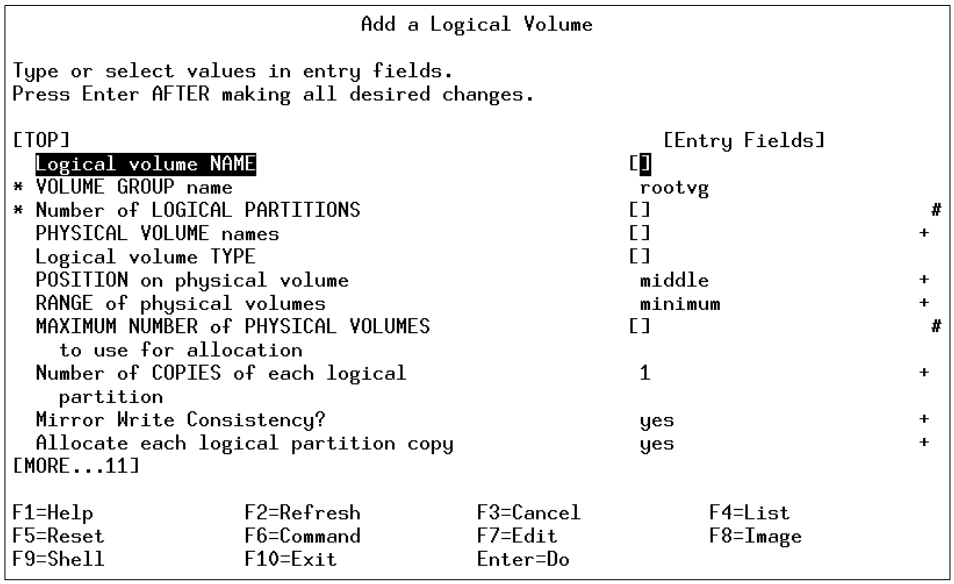

Figure 50. mklv - Step 2

4. In the Logical volume NAME field, enter the name of the logical volume you are creating (newlv in this case).
5. In the Number of LOGICAL PARTITIONS field, enter the number of logical partitions you want to assign to your new logical volume (10 in this case). Each logical partition corresponds to one or more physical partitions depending upon the number of copies of data you want to keep.
6. In the PHYSICAL VOLUME names field, enter the physical volumes that you want to use for this logical volume. If you do not specify any names, the first PV in the system will be used to place all the data on.
7. In the Number of COPIES of each logical partition field, enter the number of LP copies that you want for your data. A value of 1 to 3 is allowed.
8. Press **Enter** to create the logical volume.

6.5.2 Removing a Logical Volume

You may need to remove a logical volume if it is no longer in use for storage purposes by users and applications. The `rmlv` command can be used to remove a logical volume.

6.5.2.1 Removing a Logical Volume Using Command Line

The `rmlv` command is used to remove a logical volume. The following shows the general syntax of the command, and its commonly used flags are shown in Table 27.

```
rmlv [ -f ] [ -p Physical Volume ] LogicalVolume ...
```

Table 27. rmlv Command Flags

Flag	Description
-f	Removes the logical volumes without requesting confirmation.
-p PhysicalVolume	Removes only the logical partition on the PhysicalVolume. The logical volume is not removed unless there are no other physical partitions allocated.

The following shows the command to remove a logical volume, newlv.

```
# rmlv newlv
Warning, all data on logical volume newlv will be destroyed.
rmlv: Do you wish to continue? y(es) n(o) y
#
```

Entering a `y` as the response to this dialogue and pressing **Enter** will complete the process of deletion of a logical volume.

6.5.2.2 Removing a Logical Volume Using SMIT

Alternatively, you can use the SMIT fast path command, `smitty rmlv`, to remove a logical volume.

6.5.3 Reducing the Size of a Logical Volume

The following steps can be performed to reduce the size of a logical volume to free up excess logical partition allocation.

1. Back up all data in the logical volume.
2. Remove the logical volume.
3. Recreate the logical volume with the reduced logical partition allocation.
4. Restore the data.

The resulting free space could be put to better use by allocating it to other logical volumes requiring it.

6.5.4 Increasing the Size of a Logical Volume

An existing logical volume can be increased in size by using the `extendlv` command or SMIT.

If the logical volume is used by a journaled file system, you can also use the `chfs` command or the SMIT fast path command `smitty chjfs` to increase the size of the logical volume.

6.5.4.1 Extending a Logical Volume Using Command Line

The `extendlv` command is used to increase the size of a logical volume. The following is the general syntax of the command and its commonly used flags.

```
extendlv [ -a Position ] [ -e Range ] [ -u Upperbound ] [ -s Strict ]
LogicalVolume Partitions [ PhysicalVolume ... ]
```

The following example shows the use of the `extendlv` command to add three more logical partitions to the logical volume you created.

```
extendlv newlv 3
```

6.5.4.2 Extending a Logical Volume Using SMIT

The following SMIT fast path command can be used to increase the size of a logical volume.

```
smitty extendlv
```

6.5.5 Copying a Logical Volume

Logical volumes may need to be copied for a number of reasons. If a disk is to be removed and replaced with a new disk, the logical volumes on that disk will need to be copied to the new disk. Logical volumes can be copied to new logical volumes or to existing logical volumes that are then overwritten.

6.5.5.1 Copying a Logical Volume Using Command Line

The following example shows the use of the `cplv` command to copy a logical volume.

```
cplv -v myvg -y newlv oldlv
```

This copies the contents of `oldlv` to a new logical volume called `newlv` in the volume group `myvg`. If the volume group is not specified, the new logical volume will be created in the same volume group as the old logical volume. This command creates a new logical volume.

The following example demonstrates how to copy a logical volume to an existing logical volume.

```
cplv -e existinglv oldlv
```

This copies the contents of oldlv to the logical volume existinglv in the same volume group. Confirmation for the copy will be requested since all data in existinglv will be overwritten.

If existinglv is smaller than oldlv, then data will be lost probably resulting in corruption.

Note

Do not copy from a larger logical volume containing data to a smaller one. Doing so results in a corrupted file system because some data is not copied. This command will fail if the `cplv` creates a new logical volume, and the volume group is varied on in concurrent mode.

6.5.5.2 Copying a Logical Volume Using SMIT

Alternatively, you can use the SMIT fast path command, `smitty cplv`, to obtain a screen similar to that shown in Figure 51.

```
                              Copy a Logical Volume

Move cursor to desired item and press Enter.

  Copy over an existing logical volume
  Copy to a user created logical volume
  Copy to a system created logical volume

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

Figure 51. cplv - Step 1

1. Select **Copy over an existing logical volume**. A screen similar to Figure 52 will be shown.

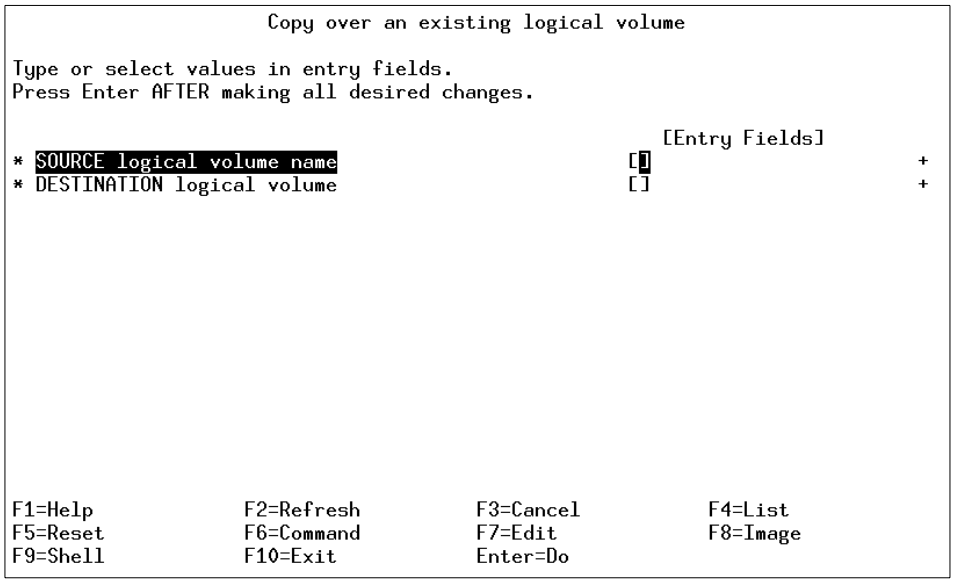

Figure 52. cplv - Step 2

2. Enter the name of the logical volume you want to copy in the SOURCE logical volume name field.
3. Enter the name of the logical volume on which you want to copy your existing logical volume onto in the DESTINATION logical volume name field. This name can be of an existing logical volume that you have already created, or it can be a new logical volume that you want to create. Press **Enter** to complete this step.

Note

You might encounter the following error:

```
cplv : Destination logical volume must have type set to copy
```

If this is the case, use the following command:

```
chlv -t copy <Destination Logical Volume Name>
```

Return to your SMIT session. Now, the system will allow you to copy the logical volume. This has been done to ensure extra security so that you do not overwrite your data accidently.

6.5.6 Listing Logical Volumes

The following logical volumes are automatically created at the system installation time.

hd5 This is the boot logical volume that holds the boot code. It is available only at the system startup time.

hd6 This is the default paging space logical volume that is used by the system to perform paging.

hd8 This logical volume is used as the default logging space for the journaled file systems.

hd4 This logical volume in used by the /, root file system.

hd2 This logical volume is used by the /usr file system.

hd9var This logical volume is used by the /var file system.

hd3 This logical volume used by the /tmp file system.

hd1 This logical volume is used by the /home file system.

The following command will list all the logical volumes defined on the system as shown in Figure 53.

```
lsvg | lsvg -il
```

```
rootvg:
LV NAME             TYPE       LPs   PPs   PVs  LV STATE      MOUNT POINT
hd5                 boot       2     2     1    closed/syncd  N/A
hd6                 paging     32    32    1    open/syncd    N/A
hd8                 jfslog     1     1     1    open/syncd    N/A
hd4                 jfs        4     4     1    open/syncd    /
hd2                 jfs        123   123   1    open/syncd    /usr
hd9var              jfs        1     1     1    open/syncd    /var
hd3                 jfs        4     4     1    open/syncd    /tmp
hd1                 jfs        1     1     1    open/syncd    /home
lv00                jfs        4     4     1    closed/syncd  /usr/vice/cache
lv01                jfs        3     3     1    open/syncd    /var/dce
lv02                jfs        10    10    1    closed/syncd  /var/dce/adm/dfs/c
ache
lvtest              ???        3     6     1    open/syncd    /test
lvbkup              ???        3     3     1    closed/syncd  N/A
lv03                jfs        108   108   1    closed/syncd  /export/lpp_source
_1
lv04                jfs        53    53    1    closed/syncd  /export/spot_1
lv05                jfs        158   158   1    closed/syncd  /work
lv06                jfs        5     5     1    closed/syncd  /home2
lv07                jfs        1     1     1    open/syncd    /auto1
lv08                jfs        1     1     1    closed/syncd  /auto2
Standard input
```

Figure 53. Logical Volume Listing

The `lslv` command can be used to view all the attributes related to a logical volume (newlv) as shown in Figure 54.

```
# lslv newlv
LOGICAL VOLUME:     newlv                    VOLUME GROUP:   rootvg
LV IDENTIFIER:      00615147b27f2b40.26      PERMISSION:     read/write
VG STATE:           active/complete          LV STATE:       closed/syncd
TYPE:               jfs                      WRITE VERIFY:   off
MAX LPs:            512                      PP SIZE:        4 megabyte(s)
COPIES:             1                        SCHED POLICY:   parallel
LPs:                1                        PPs:            1
STALE PPs:          0                        BB POLICY:      relocatable
INTER-POLICY:       minimum                  RELOCATABLE:    yes
INTRA-POLICY:       middle                   UPPER BOUND:    32
MOUNT POINT:        N/A                      LABEL:          None
MIRROR WRITE CONSISTENCY: on
EACH LP COPY ON A SEPARATE PV ?: yes
#
```

Figure 54. Logical Volume Attributes

6.5.7 Logical Volume Size

The size of a logical volume is the space that is allocated to the logical volume and is a factor of the number of logical partitions that are allocated to the logical volume and the number of copies that you have told the system to maintain. Therefore, the total space taken up by the logical volume is determined by the following formula:

Total LV size=PP size * LPs assigned to LV * Number of copies of the LV

The following example shows how to calculate the logical volume size.

If PP size is 4 MB, LPs assigned to the logical volume are 10, and the number of copies of the logical volume are 2, then the total space that will be allocated to this logical volume will be 80 MB (4*10*2).

6.6 Managing Journaled File Systems

A file system is a set of files, directories, and other structures. File systems maintain information and identify the location of a file or directory's data. In

addition to files and directories, file systems may contain a boot block, a superblock, bitmaps, and one or more allocation groups. An allocation group contains disk i-nodes and fragments.

The following three types of file systems are supported on an AIX system.

Journaled File System This native file system type is called the journaled file system (JFS). Each journaled file system resides on a separate logical volume. The operating system mounts some journaled file systems during initialization (those that are required to boot and run the system) and mounts others at that time only if directed to do so in /etc/filesystems.

Network File System The network file system (NFS) is a distributed file system that allows users to access files and directories located on remote computers and use those files and directories as if they are local.

CD-ROM File System The CD-ROM file system (CDRFS) is a file system type that allows you to access the contents of a CD-ROM through the normal file system interfaces.

The Journaled File System (JFS) divides the logical volume into a number of fixed size units called logical blocks. The logical blocks in the file system are organized as follows:

Logical Block 0 The first logical block in the file system is reserved and available for a bootstrap program or any other required information; this block is unused by the file system.

Superblock The first and thirty-first logical blocks are reserved for the superblock (logical block 31 being a backup copy). The super block contains information, such as the overall size of the file system in 512 byte blocks, the file system name, file system log device address (logs will be covered later in this section), version number, and the file system state.

Allocation Groups The rest of the logical blocks in the file system are divided into a number of allocation groups. An allocation group consists of data blocks and i-nodes to reference those data blocks when they are allocated to directories or files. These groups can be used to tailor the physical placement of data on a disk.

6.6.1 Characteristics of the Journaled File System

The size for a Journaled File System (JFS) is defined when the file system is created considering the following parameters:

- Number of i-nodes
- Allocation group size
- File system fragment addressability
- Journaled File System log size
- Maximum Journaled File System size

6.6.1.1 Number of I-nodes

The total number of i-nodes in a file system limits the total number of files and the total size of the file system. The JFS provides the nbpi (number of bytes per i-node) parameter that affects the number of i-nodes in a file system. JFS supports nbpi values of 512, 1024, 2048, 4096, 8192, 16384, 32768, 65536, and 131072. The values 32768, 65536, and 131072 only apply to AIX Version 4.2 or later.

For example, to create an 8 MB file system with an nbpi value of 4096, an i-node will be generated for each 4096 bytes of data. This would result in a maximum of 2048 i-nodes for an 8 MB file system, which means that if every file in the file system is ideally 4 KB in length, a maximum of 2048 files can be created in the file system.

The JFS restricts all file systems to 16 MB (2^{24}) i-nodes.

6.6.1.2 Allocation Group Size

AIX Version 4.2, or later, supports various allocation group sizes. The JFS segregates file system space into groupings of i-nodes and disk blocks for user data. These groupings are called allocation groups. The allocation group size can be specified when the file system is created. The allocation group sizes are 8 MB, 16 MB, 32 MB, and 64 MB. Each allocation group size has an associated nbpi range. The ranges are defined by the following table:

Table 28. Allowable nbpi Values

Allocation Group size in MB	Maximum number of i-nodes
8	512, 1024, 2048, 4096, 8192, and 16384
16	1024, 2048, 4096, 8192, 16384, and 32768
32	2048, 4096, 8192, 16384, 32768, and 65536
64	4096, 8192, 16384, 32768, 65536, and 131072

6.6.1.3 File System Fragment Addressability

The JFS supports four fragment sizes: 512, 1024, 2048, and 4096 byte units of contiguous disk space. The JFS maintains fragment addresses in i-nodes and indirect blocks as 28-bit numbers. Each fragment must be addressable by a number from 0 to 2^{28}. If a file predominately 400 byte files, a fragment size of 512 would be the most efficient, since 4096-byte fragments would be wasted space. The fragment is the smallest addressable unit of storage.

6.6.1.4 Journaled File System Log Size

Multiple Journaled File Systems use a common log, called a JFS log, configured to be 4 MB in size. For example, after initial installation, all file systems within the root volume group use the logical volume hd8 as a common JFS log. The default logical volume partition size is 4 MB, and the default log size is one partition; therefore, the root volume group normally contains a 4 MB JFS log. When file systems exceed 2 GB, or when the total amount of file system space using a single log exceeds 2 GB, the default log size needs to be increased. The JFS log is limited to a maximum size of 256 MB.

6.6.1.5 Maximum Journaled File System Size

The maximum JFS size is defined when the file system is created. For example, selecting a fragment size of 512 will limit the file system to a size of 8 GB (512 * 2^{24} = 8 GB). When creating a JFS file system, the factors listed (nbpi, fragment size, and allocation group size) need to be weighed carefully. The file system size limitation is the minimum of NPBI * 2^{24} or Fragment Size * 2^{28}.

6.6.2 Creating a File System

Every file system in AIX corresponds to a logical volume. In order to create a Journaled File System, use the following SMIT hierarchy.

1. Executing the SMIT fast path command `smitty crjfs` will show a screen similar to Figure 55.

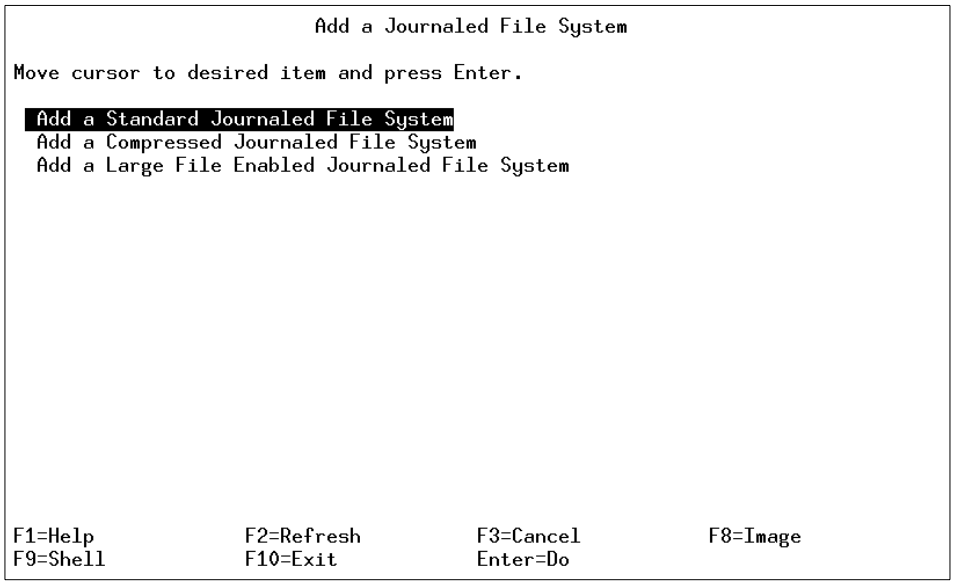

Figure 55. crjfs - Step 1

2. Select **Add a Standard Journaled File System** to add a new Journaled File System. A screen similar to Figure 56 on page 154 is displayed.

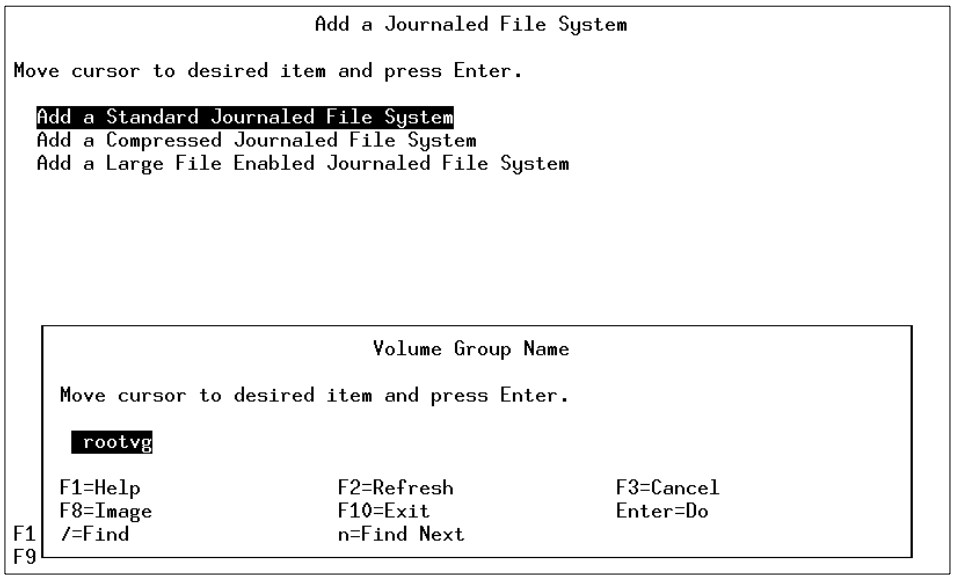

Figure 56. crjfs - Step 2

3. Select the volume group you want to add this new file system to by using the arrow keys. In this case, since there is only one volume group (rootvg), only rootvg is displayed. Select **rootvg** as your target volume group by pressing the **Enter** key.
4. Once you select the target volume group, a screen similar to Figure 57 on page 155 is displayed.

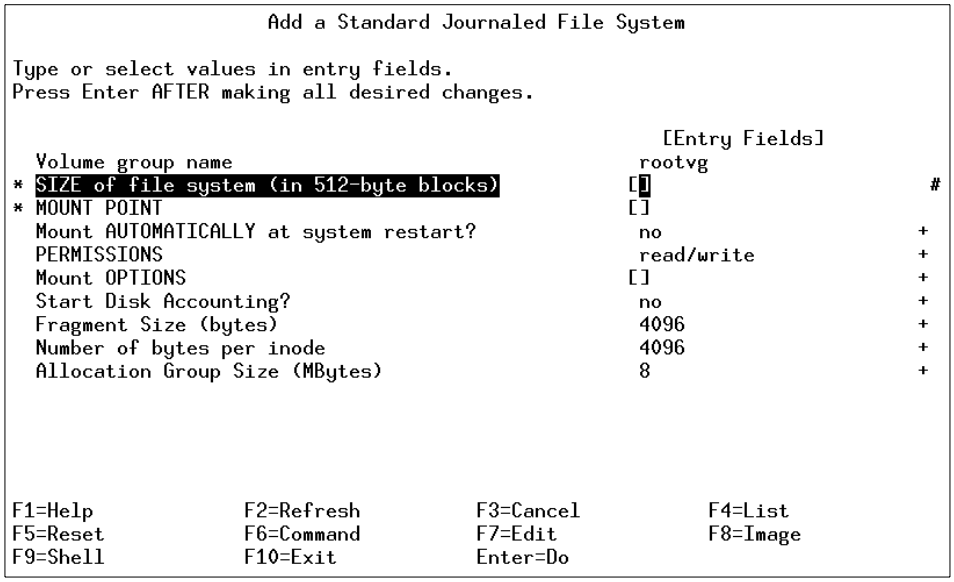

Figure 57. crjfs - Step 3

5. In the Size of file system (in 512 byte blocks) field, enter the size of the file system you want to create. For example, if you want to create a file system of 4 MB in size, you can simply multiply the number of megabytes (four in this case) with 2048 to get the number of 512-byte blocks you will need to specify to create a file system this large (8192 in this case).

Note

In AIX, all of the I/O is in 4 KB blocks; however, space is allocated in multiples of 512 byte blocks. This is done just to remain consistent with other UNIX systems. The smallest file system that you can create is equal to one PP; therefore, even if you specify that the number of blocks to be less than one PP, the system will still create a file system equal to one PP. The following example shows how to calculate the number of blocks for a given amount of space in MB.

Since,	512 bytes = 1 block
Therefore,	1024 bytes = 2 blocks
and	1 MB = 2*1024 blocks
Therefore,	x MB = x * 2048 blocks **(**Answer**)**

This indicates that the equivalent number of blocks for a file system of 2 MB are 4096 (enter this number in the Size of File System field).

6. Next, in the MOUNT POINT field, enter the full path where you want your file system to attach itself to the file system hierarchy. A mount point is a directory or file at which the new file system, directory, or file is made accessible.
7. Press **Enter** to create the Journaled File System. The screen shown in Figure 58 on page 157 indicates the successful completion of the process.

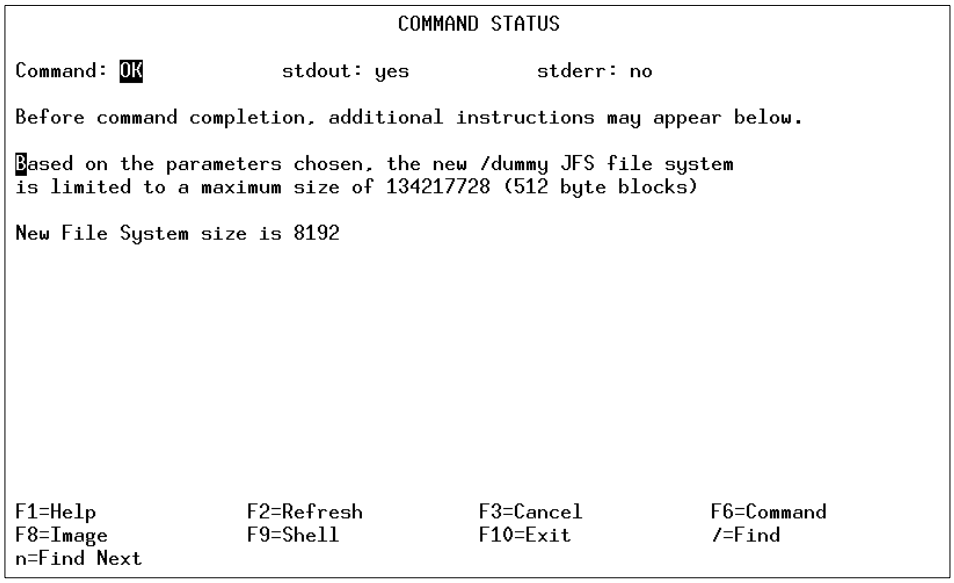

Figure 58. crjfs - Step 4

Alternatively, you can perform the same task on the command line using the following command:

```
crfs -v jfs -g rootvg -a size=8192 -m /dummy
```

This will create a journaled file system of 4 MB with `/dummy` as the mount point in the `rootvg` volume group.

6.6.3 Mounting a File System

Mounting is a concept that makes file systems, files, directories, devices, and special files available for use at a particular location. It is the only way a file system is made accessible. Once you have created the file system, the next task is to make it available to your users. In order to do that, you must know how AIX manages the patching of the newly created file systems into its file tree using the mount points.

Figure 59 on page 158 shows a file system mount point (/u/dick) before a file system is mounted over it.

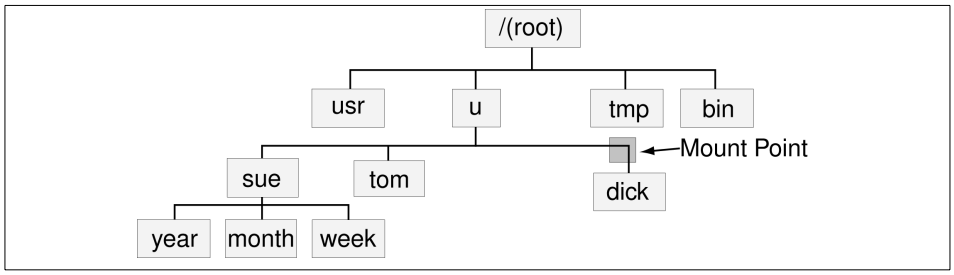

Figure 59. File Tree View before Mounting

Figure 60 shows a mounted file system /u/dick over the /u/dick mount point.

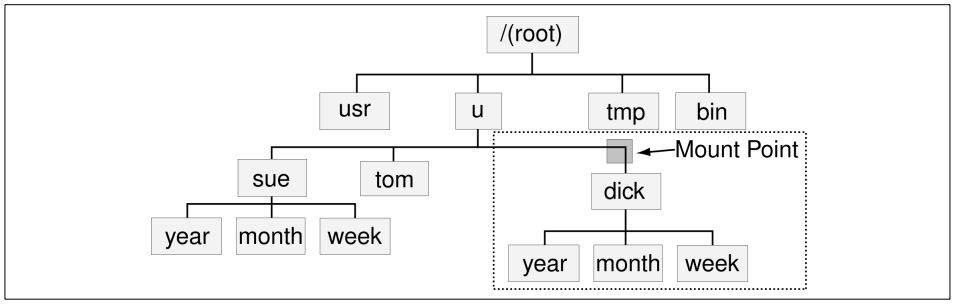

Figure 60. File Tree View after Mounting

Note

- When a file system is mounted over a directory, the permissions of the root directory of the mounted file system takes precedence over the permissions of the mount point.
- A common problem is failure of the `pwd` command. Without search permission in the mounted-over directory, the `pwd` command returns the following message:

  ```
  pwd: Permission denied
  ```

  This problem can be avoided by always setting the permissions of the mounted-over directory to at least 111.

6.6.3.1 Mounting a File System through Command Line

The following command shows how to mount a file system (`/FileSystemX`).

```
mount /FileSystemX
```

Alternatively, if you know the name of the device associated with your file system, you can use the device name to mount your newly created file system.

If you want to mount all the file systems, you can use the following command to mount all the file systems at one time.

```
mount {-a|all}
```

6.6.3.2 Mounting a File System through SMIT

A file system can be also be mounted using the following SMIT fast path hierarchy.

1. Executing `smitty mount` will display the screen shown in Figure 61.

```
                              Mount a File System

Move cursor to desired item and press Enter.

  List All Mounted File Systems
  Mount a File System
  Mount a Group of File Systems

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

Figure 61. Mount File System - Step 1

2. Use the arrow keys to move the cursor down and select **Mount a File System** by pressing the **Enter** key. A screen similar to Figure 62 on page 160 is shown:

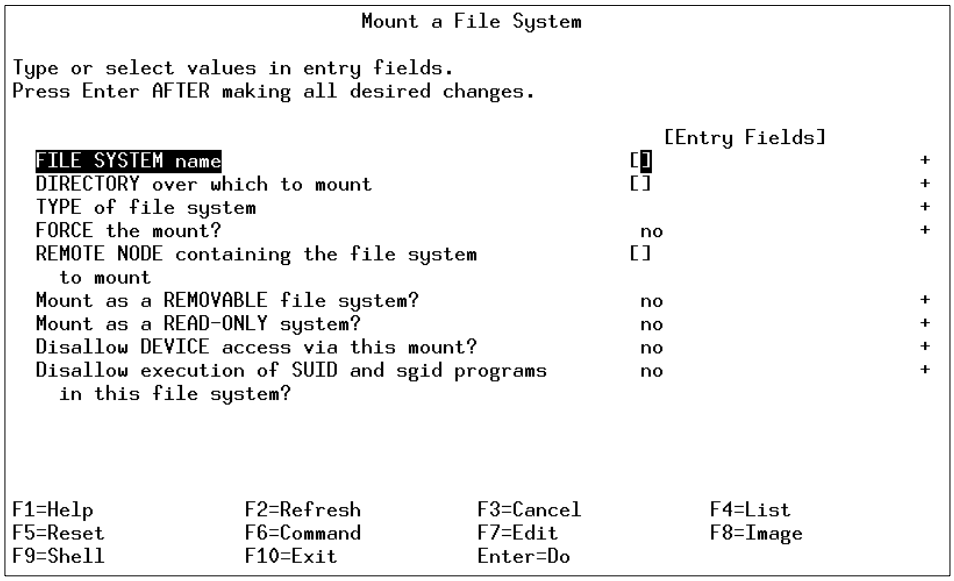

Figure 62. Mount File System - Step 2

3. Use the arrow keys to move down to DIRECTORY over which to mount.
4. Press **F4** to get a list of the mount points that you have defined for your file system (refer to 6.6.2, “Creating a File System” on page 153, to see how you created a file system, and notice that you created a mount point for your file system. You will use the same mount point to make your file system available to the users). Pressing **F4** shows a screen similar to Figure 63 on page 161.

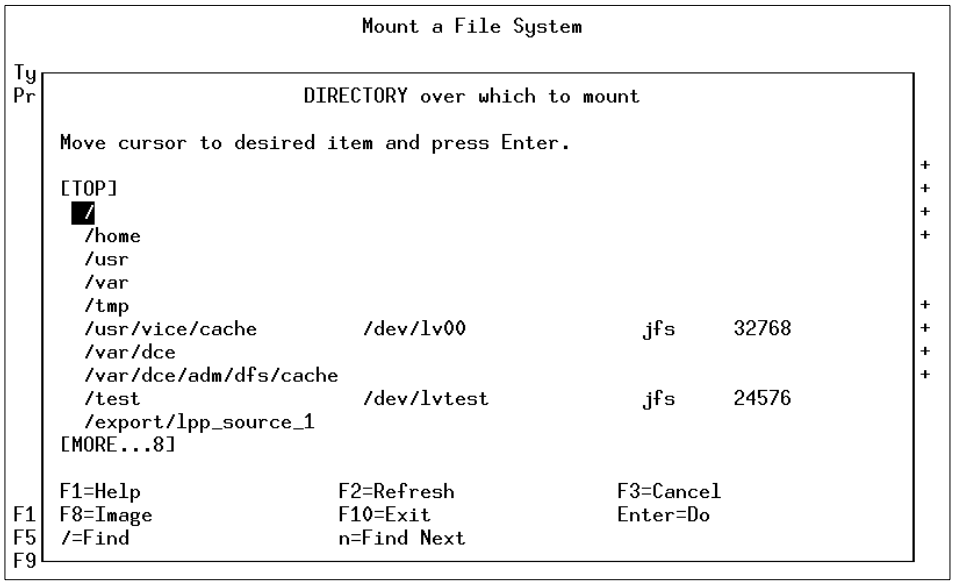

Figure 63. Mount FIle System - Step 3

5. Use the arrow keys to select the file system you want to mount. Press **Enter** to make the selection. This will display the mount point you just selected in the DIRECTORY over which to mount field.
6. Press **Enter** again and wait for the SMIT OK prompt, which indicates the successful completion of the process.

6.6.3.3 Automatic Mounting

Mounts can be set to occur automatically during system initialization. There are two types of automatic mounts:

- Those mounts that are required to boot and run the system. These file systems are explicitly mounted by the boot process. The stanzas of such file systems in the /etc/filesystems file have mount =automatic. When the multi-user initialization starts, the /etc/rc script does not try to mount these file systems again when it runs the `mount all` command. Similarly, when the `umount all` command is run, these file systems are not unmounted.
- The second type of automatic mount is user-controlled. These file systems are mounted by the /etc/rc script when it issues the `mount all` command. The stanzas of user-controlled automatic mounts have mount = true in /etc/filesystems.

You can specify a file system to be mounted automatically when you either use the `mount all` command or the by the /etc/rc script at the initialization time. You can achieve this by setting the Mount AUTOMATICALLY at system restart field to TRUE when you are creating a file system (see Figure 57 on page 155).

6.6.3.4 Displaying Mounted File Systems

The following example shows the use of the command `mount` without a flag to display information about all the currently mounted file systems.

```
# mount
node       mounted        mounted over    vfs       date        options
-------- ---------------  ---------------  ------ ------------ ---------------
         /dev/hd4         /                jfs    Oct 25 18:20 rw,log=/dev/hd8
         /dev/hd2         /usr             jfs    Oct 25 18:20 rw,log=/dev/hd8
         /dev/hd9var      /var             jfs    Oct 25 18:20 rw,log=/dev/hd8
         /dev/hd3         /tmp             jfs    Oct 25 18:20 rw,log=/dev/hd8
         /dev/lv01        /var/dce         jfs    Oct 25 18:21 rw,log=/dev/hd8
         /dev/hd1         /home            jfs    Oct 27 15:14 rw,log=/dev/hd8
         /dev/lvtest      /test            jfs    Oct 27 15:17 rw,log=/dev/hd8
         /dev/lv07        /auto1           jfs    Oct 27 15:34 rw,log=/dev/hd8
```

6.6.4 Removing a File System

The following example shows the steps involved to remove a file system.

1. Using the `mount` command to check the file systems that are currently mounted will display the following screen:

   ```
   # mount
   node       mounted        mounted over    vfs       date        options
   -------- ---------------  ---------------  ------ ------------ ---------------
            /dev/hd4         /                jfs    Oct 25 18:20 rw,log=/dev/hd8
            /dev/hd2         /usr             jfs    Oct 25 18:20 rw,log=/dev/hd8
            /dev/hd9var      /var             jfs    Oct 25 18:20 rw,log=/dev/hd8
            /dev/hd3         /tmp             jfs    Oct 25 18:20 rw,log=/dev/hd8
            /dev/lv01        /var/dce         jfs    Oct 25 18:21 rw,log=/dev/hd8
            /dev/hd1         /home            jfs    Oct 27 15:14 rw,log=/dev/hd8
            /dev/lvtest      /test            jfs    Oct 27 15:17 rw,log=/dev/hd8
            /dev/lv07        /auto1           jfs    Oct 27 15:34 rw,log=/dev/hd8
   ```

2. Identify if the file system you want to remove is shown in the list.

   Yes Continue with Step 3.

   No Go to Step 5.

3. Unmount the file system by using the `umount` command.
   `umount <filesystem name>`

4. Repeat Step 1 to check whether the file system has successfully been unmounted.

   Using the SMIT fast path command `smitty rmjfs` to remove a Journaled File System will display a screen similar to the one shown in Figure 64.

```
                        Remove a Journaled File System

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

                                                      [Entry Fields]
* FILE SYSTEM name                                    /                +
  Remove Mount Point                                  no               +









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

Figure 64. rmjfs - Step 1

5. Press **F4** to get a list of all the file systems that are defined on the system. You will obtain a screen similar to Figure 65.

```
                        Remove a Journaled File System

Ty
Pr                              FILE SYSTEM name

    Move cursor to desired item and press Enter.
*                                                                       +
    [TOP]                                                               +
      /
      /home
      /usr
      /var
      /tmp
      /usr/vice/cache
      /var/dce
      /var/dce/adm/dfs/cache
      /test
      /export/lpp_source_1
    [MORE...6]

    F1=Help                 F2=Refresh              F3=Cancel
F1  F8=Image                F10=Exit                Enter=Do
F5  /=Find                  n=Find Next
F9
```

Figure 65. rmjfs - Step 2

6. Select the file system to be removed using the arrow keys and press **Enter.**
7. The name of the file system you just selected will be shown in the FILE SYSTEM name field.
8. If you want to keep the directory name that was used to mount this file system, press **Enter** to complete the command, otherwise, change the Remove Mount Point field to YES and press **Enter** to complete the process.

6.6.5 Increasing the Size of a File System

AIX provides you with the ability to increase the size of a file system dynamically provided you have enough free space available on your disk. File systems that are low on space might create unanticipated problems.

> **Note**
>
> Whenever a file system is full, the system cannot write to it and returns you the following error:
>
> `There is not enough room in the file system`

6.6.5.1 Increasing File System Size Using the Command Line

A file system can be increased by using the `chfs` command as shown in the following steps:

1. Use the `df` command to find out the current size of the file system.
2. Calculate the number of blocks you need to add.
3. On the command line, enter the following command:

```
chfs -a size=<new size in 512-byte blocks> <file system name>
Filesystem size changed to <new size in 512-byte blocks>
```

6.6.5.2 Increasing the Size of a File System Using SMIT

To increase the file system size using the SMIT fast path command (`smitty chjfs`), perform the following steps:

1. Executing the `smitty chjfs` command will display a screen similar to Figure 66.

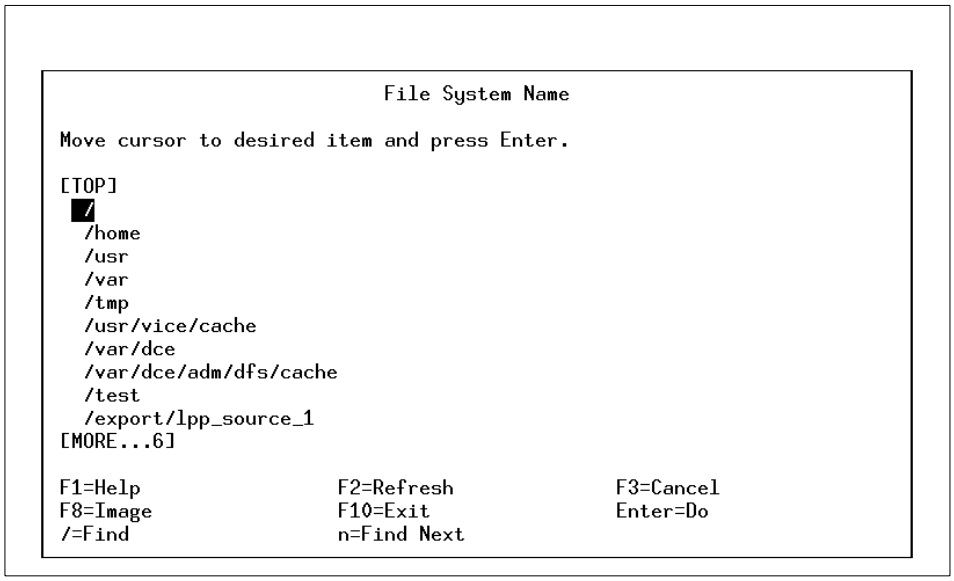

Figure 66. chjfs - Step 1

2. Use the arrow keys to select the file system you want to change and press the **Enter** key. A screen similar to Figure 67 on page 166 will be shown, which will report the current file system attributes.

```
           Change / Show Characteristics of a Journaled File System

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

                                                      [Entry Fields]
  File system name                                     /tmp
  NEW mount point                                     [/tmp]
  SIZE of file system (in 512-byte blocks)            [32768]
  Mount GROUP                                         []
  Mount AUTOMATICALLY at system restart?               yes                    +
  PERMISSIONS                                          read/write             +
  Mount OPTIONS                                       []                      +
  Start Disk Accounting?                               no                     +
  Fragment Size (bytes)                                4096
  Number of bytes per inode                            4096
  Compression algorithm                                no
  Large File Enabled                                   false
  Allocation Group Size (MBytes)                       8


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

Figure 67. chjfs - Step 2

3. Enter the new file system size that you calculated in the SIZE of file system (in 512 byte block) field.
4. Press **Enter.** The SMIT OK prompt will indicate the successful completion of the process.

6.6.6 Reducing the Size of a File System

At times, it is possible that you increased the size of a file system (for example if you had to install a new product, therefore, you increased the size of your /myfs manually to a large value). Later on, you de-installed the product which left you with a 99 percent un-utilized /myfs file system. Since this space has been allocated to the /myfs file system, it cannot be used by any other file system.

The following example shows how to reduce the size of the /myfs file system.

1. Make a backup of the /usr filesystem using any one of the following commands:
   - `cpio`
   - `backup`
   - `tar` - See section 8.2.2, “How to Backup the Current Directory” on page 205. This section also covers the `backup` and `cpio` commands.

- `savevg` - See section 8.2.1, “Backing Up a Single Volume Group” on page 204.

2. Remove the file system (/myfs) using the procedure discussed in 6.6.4, “Removing a File System” on page 162.
3. Create a new file system using the same name and reduced size. You can refer to section 6.6.2, “Creating a File System” on page 153.

Note

If you enter a value that is less than the minimum size required to contain the current data (indicated in the LV_MIN_LPs entry), the reinstallation process will fail. Use the `df -k` command to see the current blocks used in the file systems, then divide this number by 1024 to get the total MB of the file system.

4. Restore the backup of the file system into this reduced file system by using the procedure discussed in section 8.3.2, “How to Restore a Directory” on page 209.

6.6.7 Checking the File System Consistency

The `fsck` command checks file system consistency and interactively repairs the file system. The general syntax of the `fsck` command is as follows:

```
fsck [ -n ] [ -p ] [ -y ] [ -dBlockNumber ] [ -f ] [ -ii-NodeNumber ] [ -o
Options ] [ -tFile ] [ -V VfsName ] [ FileSystem1 - FileSystem2 ... ]
```

The flags commonly used with the `fsck` command and their meanings are shown in Table 29.

Table 29. fsck Command Flags

Flag	Description
-f	Performs a fast check. Under normal circumstances, the only file systems likely to be affected by halting the system without shutting down properly are those that are mounted when the system stops. The -f flag prompts the `fsck` command not to check file systems that were unmounted successfully. The `fsck` command determines this by inspecting the s_fmod flag in the file system superblock. This flag is set whenever a file system is mounted and cleared when it is unmounted successfully. If a file system is unmounted successfully, it is unlikely to have any problems. Because most file systems are unmounted successfully, not checking those file systems can reduce the checking time.

Flag	Description
-p	Does not display messages about minor problems but fixes them automatically. This flag does not grant the wholesale license that the -y flag does and is useful for performing automatic checks when the system is started normally. You should use this flag as part of the system startup procedures, whenever the system is being run automatically. This flag also allows parallel checks by group. If the primary superblock is corrupt, the secondary superblock is verified and copied to the primary superblock.
-tFile	Specifies a file parameter as a scratch file on a file system other than the one being checked if the `fsck` command cannot obtain enough memory to keep its tables. If you do not specify the -t flag, and the `fsck` command needs a scratch file, it prompts you for the name of the scratch file. However, if you have specified the -p flag, the `fsck` command will be unsuccessful. If the scratch file is not a special file, it is removed when the `fsck` command ends.
-y	Assumes a yes response to all questions asked by the `fsck` command. This flag lets the `fsck` command take any action it considers necessary. Use this flag only on severely damaged file systems.

The `fsck` command checks and interactively repairs inconsistent file systems. You should run this command before mounting any file system. You must be able to read the device file on which the file system resides (for example, the /dev/hd0 device).

Normally, the file system is consistent, and the `fsck` command merely reports on the number of files, used blocks, and free blocks in the file system. If the file system is inconsistent, the `fsck` command displays information about the inconsistencies found and prompts you for permission to repair them. If the file system cannot be repaired, restore it from backup.

Mounting an inconsistent file system may result in a system crash. If you do not specify a file system with the FileSystem parameter, the `fsck` command will check all the file systems with attribute check=TRUE in /etc/filesystems.

Note

By default, the /, /usr, /var, and /tmp file systems have the check attribute set to False (check=false) in their /etc/filesystem stanzas. The attribute is set to False for the following reasons:

1. The boot process explicitly runs the `fsck` command on the /, /usr, /var, and /tmp file systems.
2. The /, /usr, /var, and /tmp file systems are mounted when the /etc/rc file is run. The `fsck` command will not modify a mounted file system, and `fsck` results on mounted file systems are unpredictable

6.6.8 Initializing the JFS Log Device

The `logform` command initializes a logical volume for use as a JFS log device, which stores transactional information about file system metadata changes and can be used to roll back incomplete operations if the machine crashes. The following is the general syntax of the `logform` command.

```
logform LogName
```

Note

- The `logform` command is destructive; it wipes out all data in the logical volume.
- Accidentally running this on a file system completely destroys the file system's data. If a log device is open due to its use by a mounted file system, the file system should be unmounted prior to running `logform` against the log device. The `logform` command destroys all log records on existing log devices, which may result in file system data loss. You can check to ensure that the log device is closed by running the following:

  ```
  lsvg -l VGname
  ```

6.6.9 Large File Enabled File Systems

AIX 4.3 provides support for file sizes in excess of 2 GB. 64-bit processes can open files without specifically indicating that they understand large files.

With the large file support in AIX Version 4.2, there was no underlying support for file size limits in excess of 2 GB.

In file systems enabled for large files, file data stored before the 4 MB file offset is allocated in 4096 byte blocks and the file data stored beyond the 4 MB file offset is allocated with large disk blocks of 128 KB in size. The large disk blocks are actually 32 contiguous 4096 byte blocks.

For example, a 132 MB file in a file system enabled for large files has 1024 number of 4 KB disk blocks and 1024 number of 128 KB disk blocks. In a regular file system, the 132 MB file would require 33 single indirect blocks (each filled with 1024 number of 4 KB disk addresses). However, the large file geometry requires only two single indirect blocks for the 132 MB file.

6.6.9.1 Determine Large File Enabled File Systems

You can determine large file enabled file systems using the `lsfs -q filesystem` command as shown in Figure 68.

```
# lsfs -q /tmp/evar
Name            Nodename   Mount Pt               VFS   Size    Options    Auto Accounting
/dev/lv14       --         /tmp/evar              jfs   8192    rw         yes  no
  (lv size: 8192, fs size: 8192, frag size: 4096, nbpi: 4096, compress: no, bf: true, ag: 4)
# 
```

Figure 68. lsfs -q Command Output

The bf: output field in the preceding example indicates a big file. This field specifies the file system is a large file enabled if it has a value of true.

6.7 Troubleshooting File System Problems

This section will discuss some of the problems encountered while managing LVM and how to resolve them.

6.7.1 Recovering from Super Block Errors

If you receive one of the following errors from the `fsck` or `mount` commands, the problem may be a corrupted superblock.

```
fsck: Not an AIX3 file system
fsck: Not an AIXV3 file system
fsck: Not an AIX4 file system
fsck: Not an AIXV4 file system
fsck: Not a recognized file system type
mount: invalid argument
```

The problem can be resolved by restoring the backup of the superblock over the primary superblock using one of the following commands:

```
dd count=1 bs=4k skip=31 seek=1 if=/dev/lv00 of=/dev/lv00
```

The following command works only for AIX 4.x.

```
fsck -p /dev/lv00
```

Once the restoration process is completed, check the integrity of the file system by issuing the `fsck` command.

```
fsck /dev/lv00
```

In many cases, restoration of the backup of the superblock to the primary superblock will recover the file system. If this does not resolve the problem, recreate the file system and restore the data from a backup.

6.7.2 Cannot Unmount File Systems

A file system cannot be unmounted if any references are still active within that file system. The following error message will be displayed:

```
Device busy
```

or

```
A device is already mounted or cannot be unmounted
```

The following situations can leave an open references to a mounted file system.

- Files are open within a file system. Close these files before the file system can be unmounted. The `fuser` command is often the best way to determine what is still active in the file system. The `fuser` command will return the process IDs for all processes that have open references within a specified file system as shown in the following example:

  ```
  fuser -xc /tmp
  /tmp: 2910 3466 11654 26400
  ```

  The process having an open reference can be killed by using the `kill` command, and the unmount can be accomplished.

- If the file system is still busy and still cannot be unmounted, this could be due to a kernel extension that is loaded but exists within the source file system. The `fuser` command will not show these kinds of references since a user process is not involved. However, the `genkex` command will report on all loaded kernel extensions.
- File systems are still mounted within the file system. Unmount these file systems before the file system can be unmounted. If any file system is mounted within a file system, this leaves open references in the source file system at the mount point of the other file system. Use the `mount` command to get a list of mounted file systems. Unmount all the file systems that are mounted within the file system to be unmounted.

6.8 Summary of LVM Commands

This section summarizes the key commands that have been used in different sections of this chapter.

6.8.1 PV Commands

The following commands are most commonly used with physical volume related tasks.

`lsdev`	Lists devices in the ODM.
`chdev`	Changes the characteristics of a device.
`mkdev`	Adds a device to the system.
`chpv`	Changes the state of the physical volume.
`lspv`	Displays information about a physical volume within a volume group.
`migratepv`	Moves allocated physical partitions from one physical volume to one or more other physical volumes.

6.8.2 VG Commands

The following commands are most commonly used with volume group related tasks.

`mkvg`	Creates a new volume group.
`extendvg`	Adds a physical volume to a volume group.
`reducevg`	Removes physical volume from a volume group.
`chvg`	Changes a volume group.

`lsvg`	Displays information about a volume group.
`importvg`	Installs a volume group.
`exportvg`	Removes a volume group.
`reorgvg`	Reorganizes a volume group.
`syncvg`	Synchronizes a volume group.
`varyonvg`	Makes a volume group available for use.
`varyoffvg`	Makes a volume group unavailable for use.

6.8.3 LV Commands

The following are some of the most commonly used logical volume commands.

`mklv`	Creates a logical volume.
`lslv`	Lists the characteristics of a logical volume.
`rmlv`	Removes a logical volume.
`extendlv`	Increases the size of a logical volume.
`chlv`	Changes the characteristic of a logical volume.
`mklvcopy`	Adds copies to a logical volume.
`rmlvcopy`	Removes copies from a logical volume.

6.8.4 File System Commands

The following is the list of file systems commands that have been discussed in this chapter:

`chfs`	Changes the characteristics of a file system.
`crfs`	Adds a file system.
`lsfs`	Displays the characteristics of a file system.
`rmfs`	Removes a file system.
`mount`	Makes a file system available for use.
`fsck`	Checks file system consistency and interactively repairs the file system.
`umount`	Unmounts a previously mounted file system, directory, or file.
`df`	Reports information about space on file systems.

6.9 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. The system administrator has created 20 file systems that are set to mount each time the system boots. Which of the following is the *quickest* method to mount these file systems?

   A. `mount -a`

   B. Reboot the system.

   C. /usr/lib/methods/cfgfs

   D. Mount each individual file system.

2. In order to increase the size of a file system, the system administrator must:

   A. Unmount the file system.

   B. Boot the system into single user mode.

   C. Have enough free physical partitions within the volume group.

   D. Back up the file system, change the size, and restore the file system.

3. In order to decrease the size of the /home file system, the system administrator must:

   A. Use the `chfs` command.

   B. Use the `reducefs` command.

   C. Run the `defragfs` command and then use the `reducefs` command.

   D. Back up, delete, redefine, and restore the file system.

4. What is the correct sequence of steps to mirror a volume group?

   1. `extendvg`
   2. mirroring
   3. `syncvg`
   4. `set quorum`
   5. `mkfscopy`
   6. `reorgvg`

   A. 1, 2, 3, 4

   B. 1, 5, 3, 4

   C. 1, 2, 4, 6

D. 6, 5, 4, 3

5. Several error log entries indicate that hdisk5 is going bad. Before it completely fails, the system administrator decides to copy the information from that disk to the other five hard disks in that volume group. Which of the following commands should be used?

   A. `copyfs`

   B. `movelv`

   C. `populatefs`

   D. `migratepv`

6. A system has one internal disk drive (hdisk0) and one external disk drive (hdisk1).

   - hdisk0 is a 2.2 GB SCSI/2 Fastwide disk drive and contains a volume group called rootvg.
   - hdisk1 is a 4.5 GB SSA drive and contains a volume group called appsvg.
   - The external SSA drive has over 3.0 GB of free space.

   The system administrator would like to make a mirrored copy of a 500 MB logical volume that currently is on hdisk0. What would prohibit the system administrator from establishing a mirrored copy between the internal and external disk drives?

   A. The disks are not the same physical size.

   B. The disks are not within the same volume group.

   C. AIX does not support mirroring logical volume mirroring.

   D. The disks are not the same drive type (for example, SSA verses SCSI/2).

7. Which of the following commands displays the status of a physical volume (hdisk1) before adding it to a volume group called cdvg?

   A. `lsvg cdvg`

   B. `chvg cdvg`

   C. `lspv hdisk1`

   D. `chpv hdisk1`

8. What step must be taken prior to removing a file system?

   A. Unmount the file system.

   B. Remove the logical volume.

C. Delete the data from the file system.

D. Remove the NFS export for the file system.

6.9.1 Answers

The following are the answers to the previous questions:

1. A
2. C
3. D
4. A
5. D
6. B
7. C
8. A

6.10 Exercises

Provided here are some exercises you may wish to perform:

1. List all the physical volumes, volume groups, logical volumes, physical partitions, and file systems on your system.
2. Determine which disks the rootvg volume group resides on.
3. Add a new physical volume to your system and check to make sure the drive is available.
4. Create a volume group named datavg on this new physical volume.
5. Create a file system named datafiles.
6. Unmount the datafiles file system.
7. Create a mirror of datavg.
8. Determine whether you have a disk quorum.
9. Determine how many VGDA and VSGA are there for your system.
10. Increase the size of the file system, datafiles.
11. Reduce the file system, datafiles.
12. List the disks that a file system, datafiles and a volume group, and datavg reside on.

13. Remove the mirror of datavg and check to make sure the logical volume isn't mirrored.
14. Remove the datavg volume group.
15. Migrate data from any volume group other than rootvg to an unallocated drive.

Chapter 7. System Paging Space

To accommodate a large virtual memory space with a limited real memory space, the system uses real memory as a work space and keeps inactive data and programs on a disk. The area of the disk that contains this data is called the system paging space. This chapter discusses the management of system paging space related functions.

7.1 Paging Space Overview

A page is a unit of virtual memory that holds 4 KB of data and can be transferred between real and auxiliary storage.

A paging space, also called a swap space, is a logical volume with the attribute type equal to paging. This type of logical volume is referred to as a paging space logical volume or simply paging space. When the amount of free real memory in the system is low, programs or data that have not been used recently are moved from real memory to paging space to release real memory for other activities.

The installation creates a default paging logical volume (hd6) on drive hdisk0, also referred as primary paging space. The default paging space size is determined during the system customizing phase of AIX installation according to the following standards:

- Paging space can use no less than 16 MB except for hd6, which can use no less than 32 MB in AIX Version 4.2.1 and later.
- Paging space can use no more than 20 percent of the total disk space.
- If real memory is less than 32 MB, paging space is two times real memory.
- If real memory is greater than or equal to 32 MB, paging space is real memory plus 16 MB.

7.1.1 Paging Space Considerations

The amount of paging space required by an application depends on the type of activities performed on the system. If paging space runs low, processes may be lost. If paging space runs out, the system may panic. When a paging space low condition is detected, additional paging space should be defined. The system monitors the number of free paging space blocks and detects when a paging space shortage exists. The `vmstat` command obtains statistics related to this condition. When the number of free paging space blocks falls below a threshold known as the paging space warning level, the system

informs all processes (except the kernel process) of the low paging space condition.

7.1.1.1 Placement of Paging Spaces

The I/O from and to the paging spaces is random and is mostly one page at a time. The `vmstat` command reports indicate the amount of paging space I/O is taking place. A sample output of the `vmstat` command is shown in Figure 69.

```
# vmstat 5
kthr     memory             page              faults        cpu
----- ----------- ------------------------ ------------ -----------
 r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa
 0  0 16690   422   0   0   0   0    0   0 127  369  27  0  1 99  1
 0  0 16690   422   0   0   0   0    0   0 118   18  24  0  0 99  0
 0  0 16692   418   0   0   0   0    0   0 124   83  35  0  1 98  0
 0  0 16692   418   0   0   0   0    0   0 120   35  25  0  1 99  0
 0  0 16692   493   0   0   3  16   45   0 145 1812  61 15 13 64  8
 0  0 16692   493   0   0   0   0    0   0 142   13  24  0  1 99  0
 0  0 16692   493   0   0   0   0    0   0 213   24  27  0  0 99  0
```

Figure 69. vmstat Command Output

To improve paging performance, you should use multiple paging spaces and locate them on separate physical volumes whenever possible. However, more than one space can be located on the same physical volume.

7.1.1.2 Sizes of Paging Spaces

The general recommendation is that the sum of the sizes of the paging spaces should be equal to at least twice the size of the real memory of the machine up to a memory size of 256 MB (512 MB of paging space). For memories larger than 256 MB, the following rule is recommended:

Total paging space = 512 MB + (memory size - 256 MB) * 1.25

Ideally, there should be several paging spaces of roughly equal size each on a different physical disk drive. If you decide to create additional paging

spaces, create them on physical volumes that are more lightly loaded than the physical volume in rootvg.

While the system is booting, only the primary paging space (hd6) is active. Consequently, all paging-space blocks allocated during boot are on the primary paging space. This means that the primary paging space should be somewhat larger than the secondary paging spaces. The secondary paging spaces should all be of the same size to ensure that the round-robin algorithm can work effectively.

The `lsps -a` command provides a snapshot of the current utilization level of all the paging spaces on a system.

7.1.1.3 Limitations of Volume Groups Having Paging Space

Avoid adding paging space to the volume groups on portable disks because removing a disk online with an active paging space will require reboot to deactivate the paging space and, therefore, cause user disruption.

Note

A volume group that has a paging space volume on it cannot be varied off or exported while the paging space is active. Before deactivating a volume group having an active paging space volume, ensure that the paging space is not activated automatically at system initialization and then reboot the system.

7.2 Managing Paging Spaces

The following commands are used to manage paging space:

`chps`	Changes the attributes of a paging space.
`lsps`	Displays the characteristics of a paging space.
`mkps`	Creates an additional paging space.
`rmps`	Removes an inactive paging space.
`swapon`	Activates a paging space.

The `swapon` command is used during early system initialization (/sbin/rc.boot) to activate the initial paging-space device. During a later phase of initialization, when other devices become available, the `swapon` command is used to activate additional paging spaces so that paging activity occurs across several devices.

Active paging spaces cannot be removed. To remove an active paging space, it must first be made inactive. To accomplish this, use the `chps` command so the paging space is not used on the next system restart. Then, after restarting the system, the paging space is inactive and can be removed using the `rmps` command.

> **Note**
>
> Paging space cannot be deactivated dynamically. It requires a system reboot. So, any maintenance task that requires removal of paging space will have to be scheduled at an appropriate time to minimize user disruption.

The paging-space devices that are activated by the `swapon -a` command are listed in the /etc/swapspaces file as shown in the following example. A paging space is added to this file when it is created by the `mkps -a` command, removed from the file when it is deleted by the `rmps` command, and added or removed by the `chps -a` command.

```
# pg /etc/swapspaces
* /etc/swapspaces
*
* This file lists all the paging spaces that are automatically put into
* service on each system restart (the 'swapon -a' command executed from
* /etc/rc swaps on every device listed here).
*
* WARNING: Only paging space devices should be listed here.
*
* This file is modified by the chps, mkps and rmps commands and referenced
* by the lsps and swapon commands.

hd6:
        dev = /dev/hd6

paging00:
        dev = /dev/paging00

paging01:
        dev = /dev/paging01
```

7.2.1 Displaying Paging Space Characteristics

The `lsps` command displays the characteristics of paging spaces, such as the paging space name, physical volume name, volume group name, size,

percentage of the paging space used, whether the space is active or inactive, and whether the paging space is set to automatic. The paging space parameter specifies the paging space whose characteristics are to be shown.

The following examples show the use of `lsps` command with various flags to obtain the paging space information. The -c flag will display the information in colon format and paging space size in physical partitions.

```
# lsps -a -c
#Psname:Pvname:Vgname:Size:Used:Active:Auto:Type
paging00:hdisk1:rootvg:20:1:y:y:lv
hd6:hdisk1:rootvg:64:1:y:y:lv
# lsps -a
Page Space  Physical Volume   Volume Group    Size   %Used  Active  Auto
Type
paging00    hdisk1           rootvg         80MB      1     yes   yes    lv
hd6         hdisk1           rootvg        256MB      1     yes   yes    lv
# lsps -s
Total Paging Space   Percent Used
      336MB               1%
```

7.2.2 Adding and Activating a Paging Space

To make a paging space available to the operating system, you must add the paging space and then activate it. The total space available to the system for paging is the sum of the sizes of all active paging-space logical volumes.

> **Note**
>
> You should not add paging space to volume groups on portable disks because removing a disk with an active paging space will cause the system to crash.

The following example shows the steps to create a new paging space logical volume of size 20 MB in size.

1. Run the SMIT fast path `smitty mkps` to obtain a screen as shown in Figure 70 on page 184.

```
                              VOLUME GROUP name

Move cursor to desired item and press Enter.

  rootvg

F1=Help                 F2=Refresh              F3=Cancel
F8=Image                F10=Exit                Enter=Do
/=Find                  n=Find Next
```

Figure 70. smitty mkps Command

2. Use the **Arrow** keys to highlight the rootvg volume group name, and then press the **Enter** key to obtain a screen as shown in Figure 71 on page 184.
3. Type **5** for the field SIZE of paging space (in logical partitions), 5 times 4 MB results in a 20 MB paging logical volume.
4. Use the **Tab** key to toggle the field Start using this paging space NOW? from no to yes, or use the **F4** key to select it.
5. Use the **Tab** key to toggle the field Use this paging space each time the system is RESTARTED? from no to yes.

```
                          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)   [5]                    #
  PHYSICAL VOLUME name                                                  +
  Start using this paging space NOW?             yes                    +
  Use this paging space each time the system is  yes                    +
          RESTARTED?



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

Figure 71. Adding Paging Space Attributes

6. Press the **Enter** key to create the paging logical volume.

7. SMIT returns the new device name, `paging01`, with an **OK** prompt. Press the **F10** key to return to the command line.
8. You can now use the command `lsps -a` to check that the new device (`paging01`) is added and active.

```
# lsps -a
Page Space  Physical Volume   Volume Group    Size   %Used  Active  Auto  Type
paging01    hdisk1            rootvg          20MB       1     yes   yes    lv
paging00    hdisk1            rootvg          80MB       1     yes   yes    lv
hd6         hdisk1            rootvg         256MB       1     yes   yes    lv
```

7.2.3 Changing Attributes of a Paging Space

You can change only the following two attributes for a paging space logical volume.

- Activate or deactivate a paging space for the next reboot.
- Increase the size of an already existing paging space.

7.2.3.1 Deactivating Paging Spaces

The following example shows how to deactivate a paging logical volume, paging03.

1. Run the SMIT fast path command, `smitty chps`, to get to a PAGING SPACE name prompt screen as shown in Figure 72.

```
                              PAGING SPACE name

Move cursor to desired item and press Enter.

  paging03
  paging02
  paging01
  paging00
  hd6

F1=Help                 F2=Refresh              F3=Cancel
F8=Image                F10=Exit                Enter=Do
/=Find                  n=Find Next
```

Figure 72. chps Command Output

2. Use the **Arrow** keys to highlight the paging03 paging space name and then press the **Enter** key.
3. Use the **Tab** key to toggle the field Use this paging space each time the system is RESTARTED? from yes to no as shown in Figure 73.

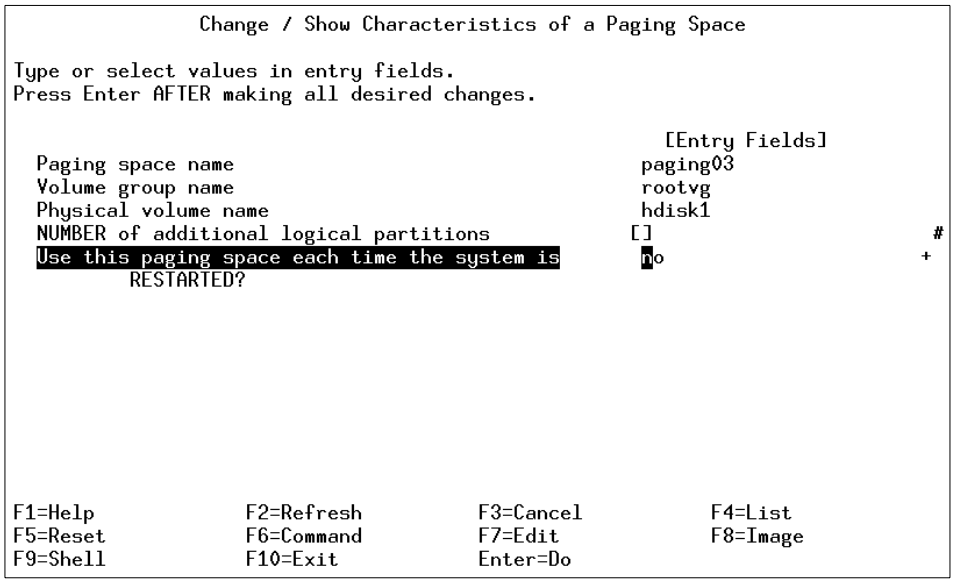

Figure 73. Changing Attributes of Paging Space

4. Press **Enter** to change the hd6 paging logical volume.
5. When SMIT returns an **OK** prompt, you can press the **F10** key to return to the command line.
6. Reboot the system and run the `lsps -a` command to confirm that status of paging03 has changed to inactive.

7.2.3.2 Increasing the Paging Spaces

The following example shows how to increase the size of an already existing paging space, paging03, by 20 MB.

1. Run the SMIT fast path command `smitty chps` to get to a PAGING SPACE name prompt screen as shown in Figure 74 on page 187.

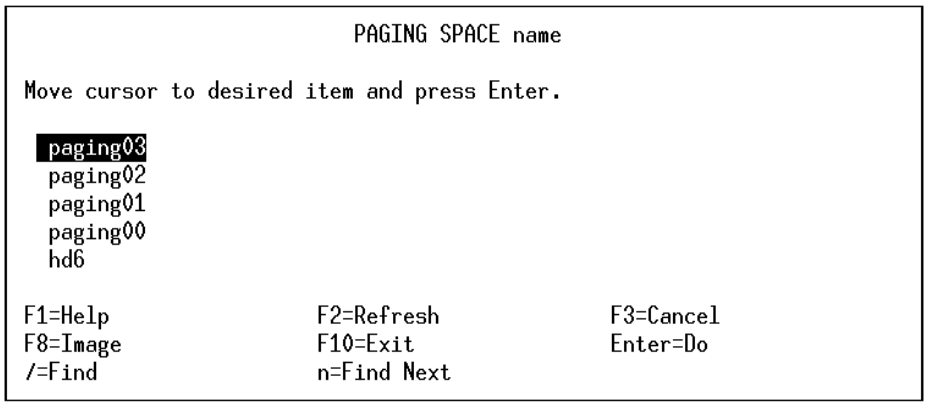

Figure 74. chps Command Output

2. Use the **Arrow** keys to highlight the paging03 paging space name and then press the **Enter** key.
3. Type **5** for the field NUMBER of additional logical partitions, as 5 times 4 MB will result in a 20 MB increase in paging space.
4. Press the **Enter** key to change the hd6 paging logical volume.
5. When SMIT returns an **OK** prompt, you can press the **F10** key to return to the command line.
6. Reboot the system and run the `lsps -a` command to confirm that the size of paging03 has increased.

7.2.4 Removing a Paging Space (Except hd6)

The following example shows the steps involved in removing an existing paging space, paging00.

Note

Removing default paging spaces incorrectly can prevent the system from restarting. This procedure should only be attempted by experienced system administrators. You must deactivate the paging space (this requires a reboot) before you can remove it.

Check the primary dump device you are using by executing the command `sysdumpdev -l`. You cannot remove the default dump device. You must change the default dump device to another paging space or logical volume before removing the paging space. To change the default dump device, use the following command:

```
sysdumpdev -P -p /dev/new_dump_device
```

1. Refer to 7.2.3, “Changing Attributes of a Paging Space” on page 185 to change the attributes of paging space, paging00, so that it will not be active after a reboot.
2. Reboot the system by executing the `shutdown -Fr` command.
3. When the system is up, login in as root and run the fast path `smitty rmps` to get to the menu with the title Remove a Paging Space. Alternatively, you can go through the SMIT hierarchy by executing the following commands:

   A. Run `smitty`.

   B. Select **System Storage Management (Physical & Logical Storage)**.

   C. Select **Logical Volume Manager**.

   D. Select **Paging Space**.

   E. Select **Remove a Paging Space** to get to the same menu.
4. Press the **F4** key to generate a list of paging logical volumes.
5. Use the **Arrow** keys to highlight the paging00 logical volume name, and then press the **Enter** key three times (once to enter the name in the field, once to get the warning, and the third time to run the command).
6. When SMIT returns an **OK** prompt with the following message, you can press the **F10** key to return to the command line.

   ```
   rmlv:Logical volume paging00 is removed
   ```

The following error message is shown when you try to remove an active paging space, paging01.

```
# lsps -a
```

```
Page Space  Physical Volume   Volume Group    Size   %Used  Active  Auto
Type
paging03    hdisk1           rootvg          4MB      0      no    no    lv
paging01    hdisk1           rootvg         20MB      1     yes   yes    lv
paging00    hdisk1           rootvg         80MB      1     yes   yes    lv
hd6         hdisk1           rootvg        256MB      1     yes   yes    lv
# rmps paging01
0517-062 rmps: Paging space paging01 is active.
0517-061 rmps: Cannot remove paging space paging01.
```

7.2.5 Managing Default Paging Space (hd6)

The default installation creates a paging logical volume (hd6) on drive hdisk0, which contains part or all of the busy / (root) and /usr file systems. System administrators may want to reduce the default paging space or move it to a less busy hard disk in order to:

- Enhance storage system performance by forcing paging and swapping to other disks in the systems that are less busy.
- Conserve disk space on hdisk0.

A special procedure is required to remove the default paging space (hd6). This paging space is activated during boot time by shell scripts that configure the system. To remove one of the default paging spaces, these scripts must be altered, and a new boot image must be created.

The following example shows the command to check your logical volume and file system distribution across a physical volume, hdisk1.

```
# lspv -l hdisk1
hdisk1:
LV NAME               LPs   PPs   DISTRIBUTION          MOUNT POINT
hd5                   2     2     02..00..00..00..00    N/A
hd6                   64    64    00..64..00..00..00    N/A
paging01              5     5     00..05..00..00..00    N/A
hd8                   1     1     00..00..01..00..00    N/A
hd4                   1     1     00..00..01..00..00    /
hd2                   73    73    00..00..73..00..00    /usr
hd9var                1     1     00..00..01..00..00    /var
hd3                   4     4     00..00..04..00..00    /tmp
hd1                   1     1     00..00..01..00..00    /home
paging00              20    20    00..00..20..00..00    N/A
paging03              1     1     00..00..01..00..00    N/A
```

7.2.5.1 Reducing the Size of hd6 Paging Space

The following example shows the steps involved in reducing the size of paging space hd6 from 160 MB to 120 MB. The steps in the following procedures are all necessary - even those not directly related to hd6. The additional steps are needed because a paging space cannot be deactivated while the system is running.

Note

- AIX Version 4.2.1, and later, does not support reducing the size of hd6 below 32 MB. If this is done, the system will not boot.
- If you decide to reduce hd6, you must leave enough space for the software in rootvg. A rule of thumb for reducing hd6 paging space is to leave enough space to match physical memory. To find out the amount of physical memory, use the following command:

  ```
  lsattr -E -l sys0 -a realmem
  ```

1. Create a temporary paging space on rootvg by executing the following command:

   ```
   mkps -a -n -s 30 rootvg hdisk0
   ```

   This command outputs the name of the paging space (paging00 if no others exist).

2. Use the following command to deactivate the hd6 paging spaces in preparation for the reboot later in the procedure.

   ```
   chps -a n hd6
   ```

3. Change the paging space entry in the /sbin/rc.boot file from:

   ```
   swapon /dev/hd6
   ```

   to

   ```
   swapon /dev/paging00.
   ```

4. Run the following command to check the primary dump device designation.

   ```
   # sysdumpdev -l
   primary              /dev/hd6
   secondary            /dev/sysdumpnull
   copy directory       /var/adm/ras
   forced copy flag     TRUE
   always allow dump    FALSE
   ```

5. If the primary dump device is hd6, change it to some other paging space. The following command shows how to change the primary dump device to paging00.

```
# sysdumpdev -P -p /dev/paging00
primary              /dev/paging00
secondary            /dev/sysdumpnull
copy directory       /var/adm/ras
forced copy flag     TRUE
always allow dump    FALSE
```

6. Create a bootable image with the `bosboot` command for a hard disk image. This step is required to update the system image used during initialization to reflect the changes made to rc.boot.

   ```
   bosboot -d /dev/hdisk0 -a
   ```

7. Put the system key (if present) in the normal position and use the following command, which will both shutdown the operating system and reboot it.

   ```
   shutdown -r
   ```

8. After the system reboots, remove the hd6 paging space.

   ```
   rmps hd6
   ```

9. Create a new paging space logical volume of the size 120 MB for the hd6 paging space.

   ```
   mklv -t paging -y hd6 rootvg 30
   ```

10. Change the primary dump device designation back to be the paging space hd6.

    ```
    sysdumpdev -P -p /dev/hd6
    ```

11. Change the paging space entry in the /sbin/rc.boot file from:

    ```
    swapon /dev/paging00
    ```

    to

    ```
    swapon /dev/hd6.
    ```

12. Create a bootable image with the `bosboot` command for a hard disk image.

    ```
    bosboot -d /dev/hdisk0 -a
    ```

13. Run the following command to make the new hd6 paging space automatically activate when the system reboots.

    ```
    chps -a y hd6
    ```

14. Run the following command to change the attribute of temporary paging space, paging00, so that it does not automatically activate after the next reboot.

    ```
    chps -a n paging00
    ```

15. Put the system key (if present) in the normal position and use the following command to shutdown and reboot the system:

```
shutdown -r
```

16. After the system reboots, remove the temporary paging space.

```
rmps paging00
```

17. Use the `lsps -a` command to verify the reduced size of the default paging space (hd6).

7.2.5.2 Moving the hd6 Paging Space to Another Volume Group

Moving a paging space with the name hd6 from rootvg to another volume group is not recommended because the name is hard-coded in several places.

Only the paging spaces in rootvg will be active during the second phase of the boot process, and having no paging space in rootvg could severely affect system boot performance. If you want the majority of paging space on other volume groups, it is better to make hd6 as small as possible (the same size as physical memory) and then create larger paging spaces on other volume groups.

7.2.5.3 Moving the hd6 Paging Space within the Same VG

Moving the default paging space from hdisk0 to a different disk within the same volume group does not require system reboot.

The following example shows the command to move the default (hd6) paging space from `hdisk0` to `hdisk1`.

```
migratepv -l hd6 hdisk0 hdisk1
```

This may take few minutes depending upon the size of paging space.

7.3 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. The system administrator realizes that paging space, paging12, must first be removed from hdisk12. Which of the following is the correct sequence of events?

   A. `chps -an paging12`, reboot, `rmps paging12`

   B. `swapoff paging12`, `rmps paging12`

   C. `swapoff paging12`, `reboot`, `rmps paging12`

   D. `chps -an paging12`, `swapoff paging12`, `rmps paging12`

2. A customer would like to remove an unneeded, but active, paging space called paging00. What is proper sequence of steps to accomplish this?

   A. Remove the paging space by using the `rmps` command and reboot the system.

   B. Disable the paging space by using the `chps` command, reboot the system, and remove the paging00 logical volume by using the `rmps` command.

   C. Disable the paging space by using the `chps` command, remove the paging00 logical volume by using the `rmps` command, and reboot the system.

   D. Disable the paging space by using the `chps` command, reboot the system, and remove the paging00 logical volume by using the `rmlv` command.

3. A system administrator would like to list all paging spaces residing on the server. What is the correct syntax of the command in order to accomplish this?

   A. `lsps -a`

   B. `lsps -s`

   C. `lsps -l`

   D. `lsps -all`

7.3.1 Answers

The following are the answers to the previous questions:

1. A
2. B
3. A

7.4 Exercises

Provided here are some exercises you may wish to perform:

1. Determine the paging spaces on a system by using the `lsps` command.
2. How to add a new paging space logical volume of size of 5 MB to the system.
3. Discuss all the steps involved in decreasing the size of the default paging space.
4. Discuss the precautions you would take before removing a paging space.

5. How can you change the primary dump device?
6. How can you move the hd6 paging space from one hdisk to another within same volume group?
7. Which command will display the paging activity status on the system?
8. How to increase the paging space logical volume size by 10 MB.
9. How the process of decreasing hd6 paging space different from decreasing any other paging space on the system.

Chapter 8. System Backup, Restores, and Availability

There are various commands you can use to make backups of systems. The following commands are the most common. A short description of each is given with a list of commands and flags in Table 30.

`tar` The `tar` command manipulates archives by writing files to, or retrieving files from, an archive storage medium. The files used by the `tar` command are represented by the File parameter. If the File parameter refers to a directory, then that directory and, recursively, all files and directories within it are referenced as well.

`cpio` The `cpio` command copies files into and out of archive storage and directories.

`dd` The `dd` command reads the *InFile* parameter or standard input, does the specified conversions, then copies the converted data to the *OutFile* parameter or standard output. The input and output block size can be specified to take advantage of raw physical I/O.

`mksysb` The `mksysb` command creates an installable image of the root volume group either in a file or onto a bootable tape.

`backup` The `backup` command creates copies of your files on a backup medium, such as a magnetic tape or diskette. The copies are in one of the two backup formats: Either specific files backed up (using the -i flag), or the entire file system backed up by i-node

`restore` The `restore` command reads archives created by the backup command and extracts the files stored on them. These archives can be in either file-name or file-system format.

Table 30. List of Backup Commands and Flags

Command	Flags	Description
`tar`	-x	Extracts the files from the archive.
	-c	Creates a new archive and writes the files specified.
	-t	Lists the files in the order in which they appear in the archive.
	-f *Archive*	Uses the Archive variable as the archive to be read or written. For example, /dev/fd0.
	-p	Says to restore fields to their original modes ignoring the present umask.

Command	Flags	Description
	-v	Lists the name of each file as it is processed.
cpio	-i	Reads from standard input an archive file created by the cpio -o command and copies from it the files with names that match the Pattern parameter.
	-o	Reads file path names from standard input and copies these files to standard output.
	-c	Reads and writes header information in ASCII character form. If a cpio archive was created using the -c flag, it must be extracted with a -c flag.
	-v	Lists file names.
	-d	Creates directories as needed.
	-u	Copies unconditionally. An older file now replaces a newer file with the same name.
	-m	Retains previous file modification time. This flag does not work when copying directories.
	-B	Performs block input and output using 512 bytes to a record.
dd	if=*InFile*	Specifies the input file name; standard input is the default.
	of=*OutFile*	Specifies the output file name; standard output is the default.
	skip=*SkipInput Blocks*	Skips the specified SkipInputBlocks value of input blocks before starting to copy.
savevg	-i	Creates the data file by calling the mkvgdata command.
	-f *Device*	Specifies the device or file name on which the image is to be stored. The default is the /dev/rmt0 device.
	-e	Excludes files specified in the /etc/exclude.*vgname* file from being backed up by this command.
mksysb	-e	Excludes files listed in the /etc/exclude.rootvg file from being backed up.
backup	-i	Specifies that files be read from standard input and archived by file name.

Command	Flags	Description
	-p	Specifies that the files be packed, or compressed, before they are archived. Only files of less than 2 GB are packed. This option should only be used when backing up files from an inactive file system. Modifying a file when a backup is in progress may result in corruption of the backup and an inability to recover the data. When backing up to a tape device that performs compression, this option can be omitted.
	-q	Indicates that the removable medium is ready to use. When you specify the -q flag, the `backup` command proceeds without prompting you to prepare the backup medium. Press the **Enter** key to continue.
	-v	Causes the `backup` command to display additional information about the backup.
restore	-d	Indicates that, if the File parameter is a directory, all files in that directory should be restored. This flag can only be used when the archive is in filename format.
	-f ***Device***	Specifies the input device. To receive input from a named device, specify the Device variable as a path name (such as /dev/rmt0). To receive input from the standard output device, specify a - (minus sign).
	-q	Specifies that the first volume is ready to use and that the restore command should not prompt you to mount the volume and press **Enter**.
	-r	Restores all files in a file system archive.
	-s *SeekBackup*	Specifies the backup to seek and restore on a multiple-backup tape archive. The -s flag is only applicable when the archive is written to a tape device. To use the -s flag properly, a no-rewind-on-close and no-retension-on-open tape device, such as /dev/rmt0.1 or /dev/rmt0.5, must be specified
	-t	Displays information about the backup archive. If the archive is in file-system format, a list of files found on the archive is written to standard output.

Command	Flags	Description
	-T	Displays information about the backup archive. If the archive is in file-name format, the information contained in the volume header and a list of files found on the archive are written to standard output.
	-v	Displays additional information when restoring.
	-x	Restores individually named files specified by the File parameter.

8.1 The mksysb Command

The `mksysb` command creates a bootable image of all mounted file systems on the rootvg volume group. You can use this backup command to reinstall a system to its original state.

The tape format includes a boot image, a bosinstall image, and an empty table of contents followed by the system backup (root volume group) image. The root volume group image is in backup-file format starting with the data files and then any optional map files.

User-defined paging spaces and raw devices are not backed up.

8.1.1 System Administrator Backup Plan

You should use the following as a guideline:

- Back up everyday recyling your backup media.
- Once per week, recycle all daily backup media except the Friday backup media.
- Once per month, recycle all Friday backup media except for the one from the last Friday of the month. This makes the last four Friday backups always available.
- Once per quarter, recycle all monthly backup media except for the last one. Keep the last monthly backup media from each quarter indefinitely, perhaps in a different building.

8.1.2 Saving the System State Information Using mkszfile

The `mkszfile` command saves the system state for reinstallation on the current system or on another system. The information saved includes the following:

- System installation information
- Logical volume information for the root volume group
- File system information.

The saved information allows the bosinstall routine to recreate the logical volume information as it existed before the backup.

The `mkszfile` command creates the /image.data file. The contents of this file are defined by the system in which the image was created. The user can edit the /image.data file before calling the `mksysb` command. The `mksysb` command, in turn, only backs up the file systems specified in the /image.data file, which reflects the requirements of the rootvg file system.

8.1.3 Excluding File Systems from a Backup

When you need to make a `mksysb` of a system, and you want to exclude some data file systems from the system, you need to edit the /etc/exclude.rootvg file. If, for example, you want to exclude the file systems /usr and /tmp, from your `mksysb` backup, ad the following:

```
/usr/
/tmp/
```

Make sure there are no empty lines in this file. You can list the contents of the file as follows:

```
# cat exclude.rootvg
/usr/
/tmp/
```

Then run the `mksysb` command using the -e flag to exclude the contents of the exclude.rootvg file as follows:

```
mksysb -e /dev/rmt0
```

8.1.4 How to Create a Bootable System Backup

The `mksysb` command creates a bootable image of the rootvg file system either in

- in a file system directory
- onto a bootable tape

and is used to restore a system after a system failure or for system cloning.

To use `smitty` to create a bootable system backup, follow the steps below:

1. Run the `smitty` Command. Select the **System Storage Management (Physical & Logical Storage)** field as shown in Figure 75.

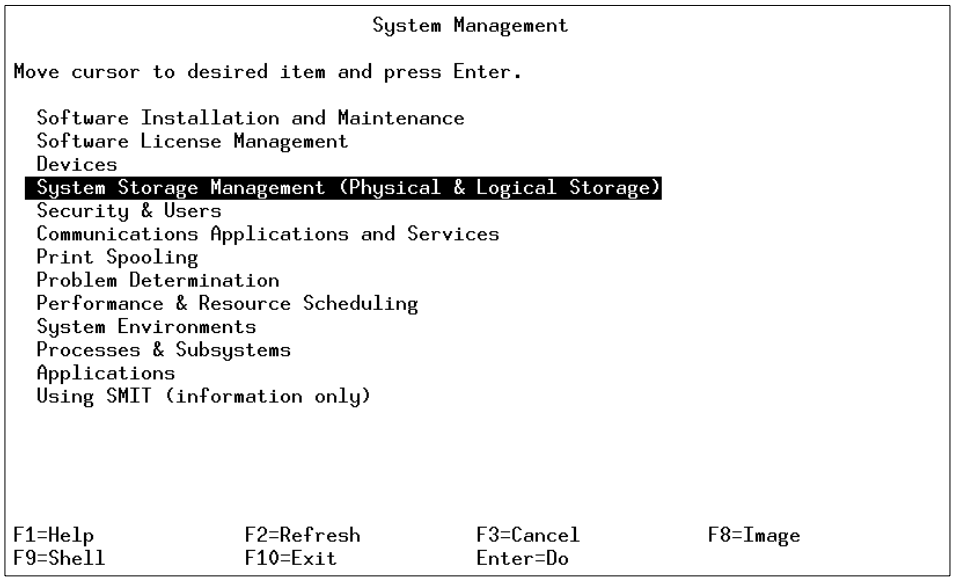

Figure 75. System Management Menu Window

2. Once in the System Storage Management Menu, select the **System Backup Manager** field as shown in Figure 76.

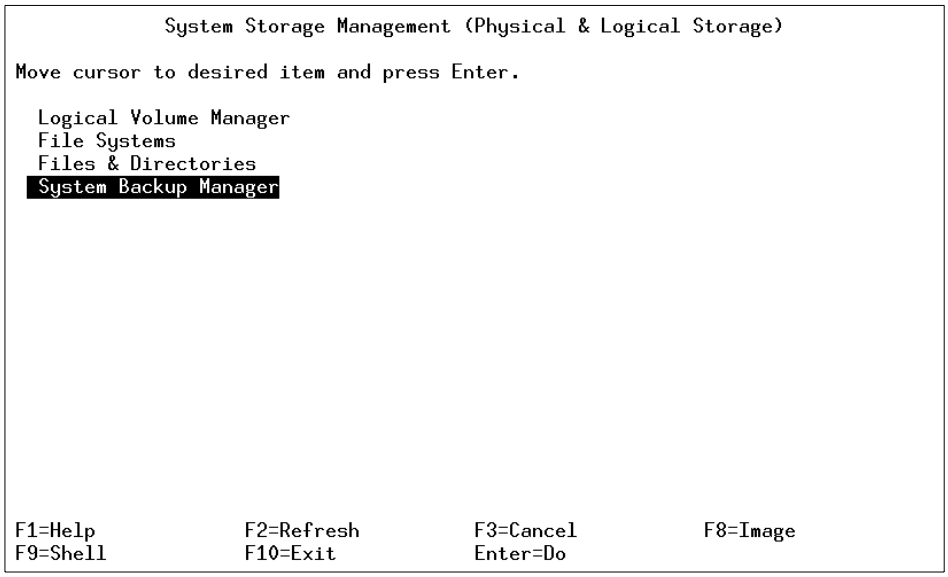

Figure 76. System Storage Management Menu Window

3. In the System Backup Manager Window, select the **Back Up the System** field as shown in Figure 77.

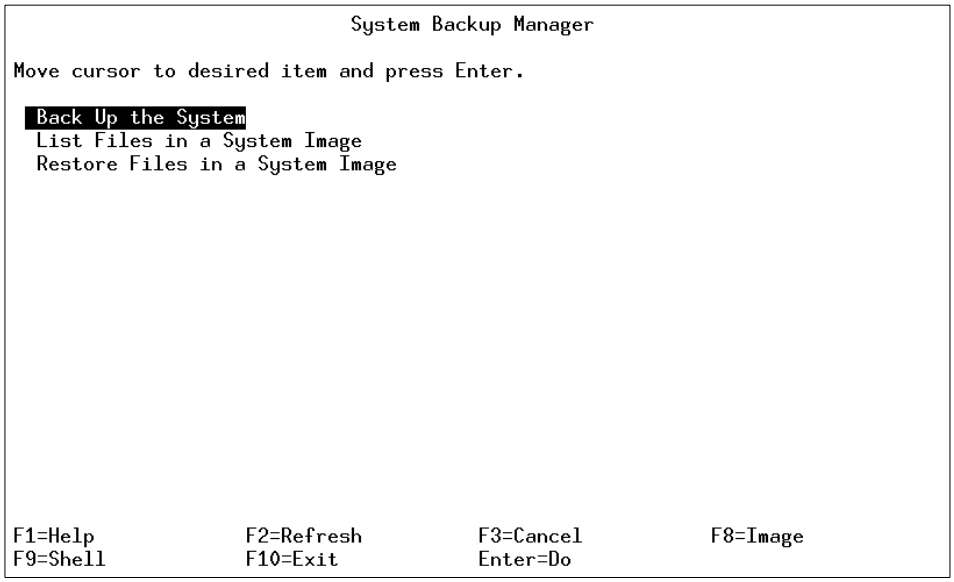

Figure 77. System Backup Manager Menu Window

4. In the Back Up the System menu, select **Backup DEVICE or FILE** field. This is where you would select your backup device, if you press **F4,** it will give you a list of backup devices. Choose the device you want and then press **Enter** as shown in Figure 78.

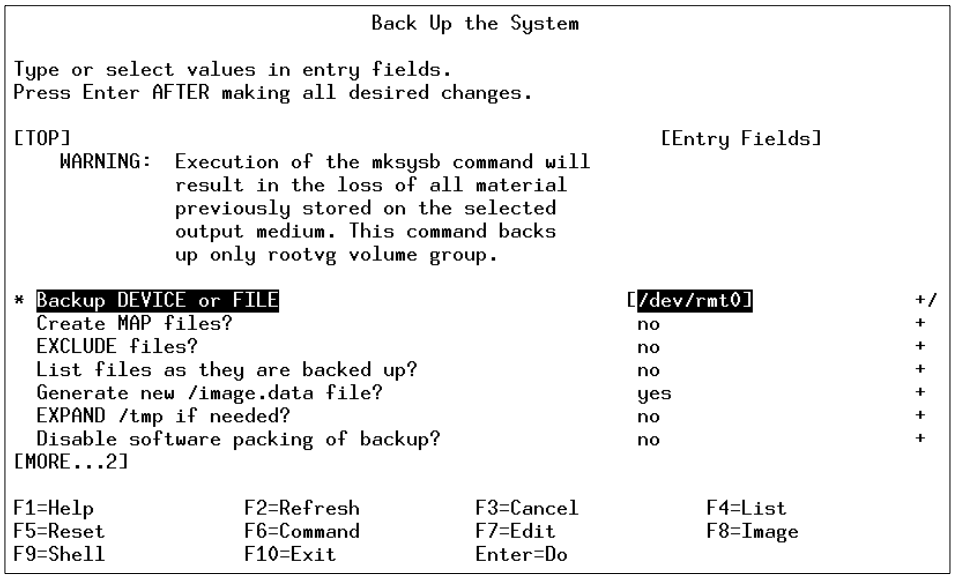

Figure 78. Back Up the System Selection Screen

5. The Command Status screen is now displayed. In Figure 79, you can see what information is being displayed during the backup process. In Figure 80 is the display for the successful completion of the backup process.

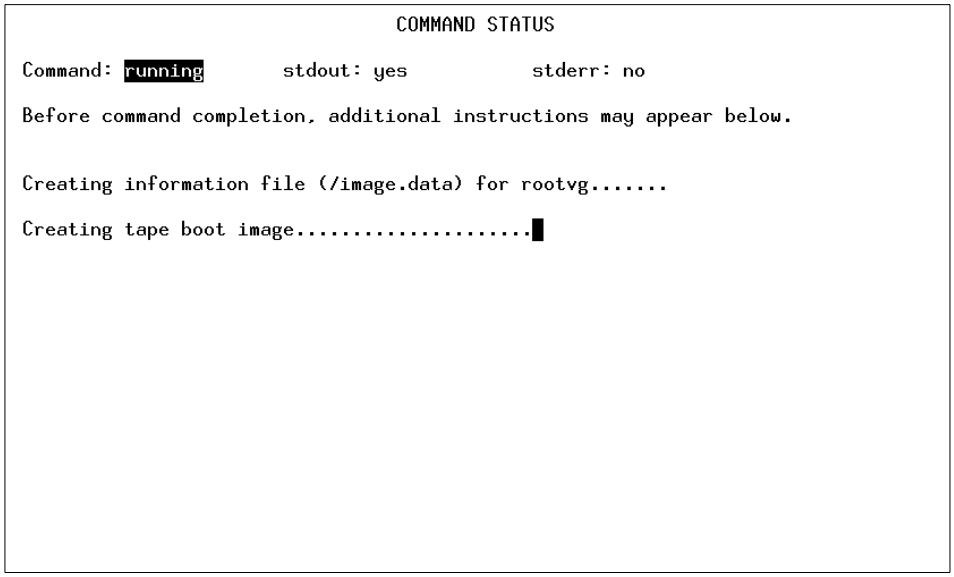

Figure 79. COMMAND STATUS Screen during Operation

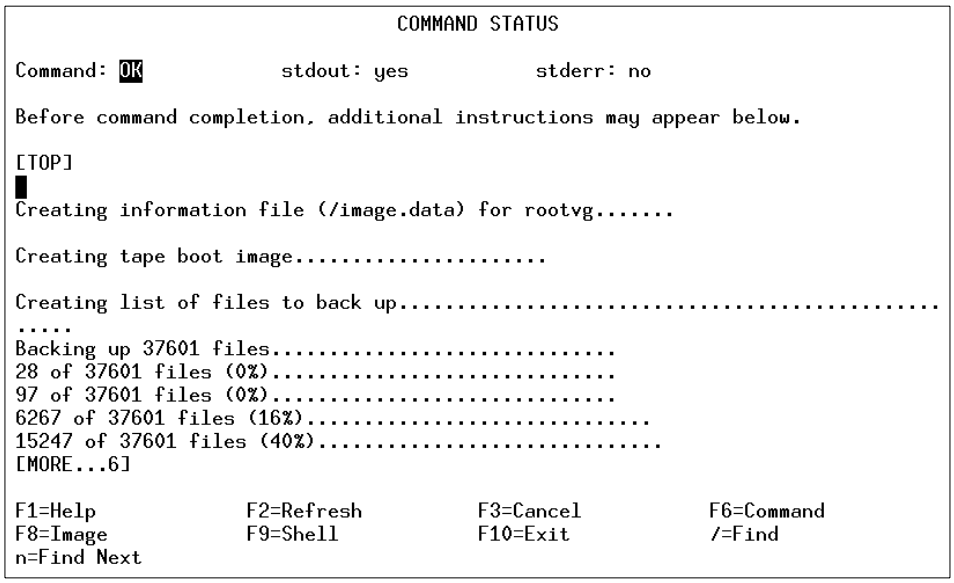

Figure 80. COMMAND STATUS Screen once Operation Completed

6. The system has now created a bootable system backup.

8.1.5 Using mksysb to Back Up a User Volume Group

You cannot run `mksysb` against a user volume group, only on rootvg. If you want to back up a user volume group, you must use `savevg, tar, cpio`, or `backup`.

8.2 Backing Up User Information

To backup user information, you can use one of the following commands:

`savevg` Finds and backs up all files belonging to a specified volume group.

`tar` Manipulates archives by writing files to, or retrieving files from, an archive storage medium.

`cpio` Copies files into and out of archive storage and directories.

`backup` Creates copies of your files on a backup medium.

8.2.1 Backing Up a Single Volume Group

The `savevg` command finds and backs up all files belonging to a specified volume group. A volume group must be varied on, and the file systems must be mounted. The `savevg` command uses the data file created by the `mkvgdata` command.

To back up the uservg volume group and create a new uservg.data file, do the following:

Check which volume group you want to back up.

```
# lsvg
rootvg
uservg
```

If you are satisfied that the volume group that must be backed up is uservg, proceed with the backup as follows:

```
# savevg -if /dev/rmt0 uservg
Creating list of files to back up....
Backing up 9077 files.................................
4904 of 9077 files (54%).....................................
8798 of 9077 files (96%).....................................
8846 of 9077 files (97%).....................................
9029 of 9077 files (99%).....................................
0512-038 savevg: Backup Completed Successfully.
```

8.2.2 How to Backup the Current Directory

To back up your current directory to the tape device /dev/rmt0, use the following example.

Check that you are in the correct directory and then list the contents of the directory.

```
# cd /userdirectory
# pwd
/userdirectory
# ls -l
total 1808
-rw-r--r--   1 root     system         0 Oct 22 18:20 DKLoadLog
-rw-r--r--   1 root     system         0 Oct 22 18:20 adnan.gif
-rw-r--r--   1 root     system         0 Oct 22 18:20 aixhelp
-rw-r--r--   1 root     system     51200 Oct 22 18:20 backup1
-rw-r--r--   1 root     system         0 Oct 22 18:20 cde-help
-rw-r--r--   1 root     system         0 Oct 22 18:20 cde-main
-rw-r-----   1 root     system        25 Oct 22 18:20 cfgvg.out
-rw-r--r--   1 root     system         0 Oct 22 18:20 dtappint.log
-rw-r--r--   1 root     system         0 Oct 22 18:20 filelist
-rw-r--r--   1 root     system         0 Oct 22 18:20 httpd-pid
-rw-r--r--   1 root     system         0 Oct 22 18:20 mk_netboot
-rw-r--r--   1 root     system         0 Oct 22 18:20 nim1.gif
-rw-r--r--   1 root     system         0 Oct 22 18:20 nimM.gif
drwxr-xr-t   2 root     system      1024 Oct 22 18:20 tmp
-rw-r--r--   1 root     system         0 Oct 22 18:20 xlogfile
-rwxr-x--x   1 root     system    864256 Oct 22 18:20 xv
```

Now that you know what is in the directory, you can now back it up using the following command:

```
# tar -cvf /dev/fd0 *
```

The flags used are -c to create the archive, -v to list the archive contents, and -f to select the device. A more comprehensive list of flags can be found in Table 30 on page 195.

```
a DKLoadLog 0 blocks.
a adnan.gif 0 blocks.
a aixhelp 0 blocks.
a backup1 100 blocks.
a cde-help 0 blocks.
a cde-main 0 blocks.
a cfgvg.out 1 blocks.
a dtappint.log 0 blocks.
a filelist 0 blocks.
a httpd-pid 0 blocks.
```

```
a mk_netboot 0 blocks.
a nim1.gif 0 blocks.
a nimM.gif 0 blocks.
a tmp
a tmp/.strload.mutex 0 blocks.
a tmp/.oslevel.mlinfo.cache 53 blocks.
a xlogfile 0 blocks.
a xv 1688 blocks.
```

Note

The tar command is one of very few commands that does not require a - (minus) sign before a flag.

There are two other commands that you can use to create backups. Using the scenario of backing up /userdirectory, you can either use backup or cpio.

- Using the backup command:

  ```
  # cd /userdirectory
  # find . -depth | backup -i -f /dev/rmt0
  ```

  This will do a backup using relative path names, which means that when you restore the information using the restore command, you need to be in the /userdirectory directory, or else it will restore the information into your current directory.

- Using the cpio command:

  ```
  # cd /
  # find /userdirectory -depth | cpio -o -c -v -B > /dev/rmt0
  ```

  This will back up the information using absolute pathnames. This information is restored using the cpio command with the -i flag. You can restore this from anywhere, and it will restore to the directory /userdirectory.

Relative or absolute pathnames can be used by either the backup command or the cpio command.

8.3 Restoring Information from Backup Media

When you restore information, you are taking information that you backed up in the previous section and using one of the restore methods discussed in the following sections.

8.3.1 How to Restore a File

For this example, you will restore the file /etc/hosts from a tape device /dev/rmt0.

You can use one of the following commands depending on what command was used to do the backup:

- `mksysb`

  There are three other images (boot image, bosinstall image, and empty table of contents) that precede the `backup` files in a `mksysb`. You can move past them using `mt` or `tctl` and the no-rewind option on the tape, or you can use the -s4 flag in the restore command.

  Rewind the tape to the beginning.

  ```
  tctl -f /dev/rmt0 rewind
  ```

  List the information on the backup media.

  ```
  # restore -T -d -v -q -s4 -f /dev/rmt0.1
  New volume on /dev/rmt0.1:
  Cluster size is 51200 bytes (100 blocks).
  The volume number is 1.
  The backup date is: Tue Oct 27 10:15:25 CST 1998
  Files are backed up by name.
  The user is root.
  .......... (Lines Removed)
           528 ./tmp/vgdata/rootvg/hd1.map
           972 ./tmp/vgdata/rootvg/hd2.map
            48 ./tmp/vgdata/rootvg/hd3.map
            36 ./tmp/vgdata/rootvg/hd4.map
           588 ./tmp/vgdata/rootvg/hd9var.map
             0 ./etc
           901 ./etc/hosts
             0 ./home
             0 ./home/lost+found
             0 ./home/guest
             0 ./home/ftp
           254 ./home/ftp/.profile
             0 ./home/ftp/bin
         18774 ./home/ftp/bin/ls
             0 ./home/ftp/etc
             0 ./home/ftp/pub
        150841 ./home/ftp/pub/aix-1-let.ps
  .......... (Lines Removed)
  The total size is 509575953 bytes.
  The number of archived files is 37773.
  ```

This screen scrolls down showing you all the files on the backup medium. If you want to show only the header information, you can leave out the -T and -v flags.

Change to the /etc/ directory and list all files with the word hosts in them. Notice that the hosts file is missing.

```
# cd /etc
# ls -l hosts*
-rw-r--r--   1 root     system      2060 Aug 25 09:41 hosts.equiv
-rw-rw-r--   1 root     system      1906 Aug 25 09:41 hosts.lpd
```

Change to the root directory and check your current directory.

```
# cd /
# pwd
/
```

Rewind the tape device.

```
tctl -f /dev/rmt0 rewind
```

Restore the file that you want. Notice the . (point) before /etc/hosts; this needs to be part of the `restore` command.

```
# restore -x -d -v -q -s4 -f /dev/rmt0.1 ./etc/hosts
New volume on /dev/rmt0.1:
Cluster size is 51200 bytes (100 blocks).
The volume number is 1.
The backup date is: Tue Oct 27 10:15:25 CST 1998
Files are backed up by name.
The user is root.
x         1848 ./etc/hosts
The total size is 1848 bytes.
The number of restored files is 1.
```

The information from the tape device during the restore operation is displayed.

Change your directory to /etc and list the files beginning with hosts.

```
# cd /etc
# ls -l hosts*
-rw-rw-r--   1 root     system      1848 Sep 10 13:44 hosts
-rw-r--r--   1 root     system      2060 Aug 25 09:41 hosts.equiv
-rw-rw-r--   1 root     system      1906 Aug 25 09:41 hosts.lpd
```

Check if the file has been restored.

- `tar`

The following example shows the command syntax you would use to restore the file /etc/hosts using the `tar` command.

```
tar -x -v -f /dev/rmt0 /etc/hosts
```

- cpio

  The following shows the command syntax you would use to restore the file /etc/hosts using the cpio command. Notice that " (quotes) are used in your file selection.

  ```
  cpio -i -c -v -d -u -m -B < /dev/rmt0 "/etc/hosts"
  ```

- restore

  The next two examples show the command syntax you would use to restore the file /etc/hosts using the restore command.

  The following shows how to restore the file /etc/hosts from a backup that was made using the -i flag option during a backup by file name. Notice the -d flag is used to restore the file.

  ```
  restore -x -d -v -q -f /dev/rmt0 /etc/hosts
  ```

  The following shows how to restore the file /etc/hosts when a file system backup was used to make the backup.

  ```
  restore -x -v -q -f /dev/rmt0 /etc/hosts
  ```

8.3.2 How to Restore a Directory

For this example, you will restore the directory /var and its contents from a tape device /dev/rmt0.

You can use one of the following commands depending on what command was used to do the backup.

- mksysb

  Remember there are three other images (boot image, bosinstall image and empty table of contents) that precede the backup files in a mksysb. Move past them using either the mt or tctl commands with the norewind option on the tape or use the -s4 flag option.

  Rewind the tape to the beginning.

  ```
  tctl -f /dev/rmt0 rewind
  ```

  List the files on the backup media using the restore command:

  ```
  # restore -T -d -v -q -s4 -f /dev/rmt0.1
  New volume on /dev/rmt0.1:
  Cluster size is 51200 bytes (100 blocks).
  The volume number is 1.
  The backup date is: Tue Oct 27 10:15:25 CST 1998
  Files are backed up by name.
  The user is root.
  ```

```
.......... (Lines Removed)
         528 ./tmp/vgdata/rootvg/hd1.map
         972 ./tmp/vgdata/rootvg/hd2.map
          48 ./tmp/vgdata/rootvg/hd3.map
          36 ./tmp/vgdata/rootvg/hd4.map
          24 ./tmp/vgdata/rootvg/hd5.map
         768 ./tmp/vgdata/rootvg/hd6.map
          12 ./tmp/vgdata/rootvg/hd8.map
         588 ./tmp/vgdata/rootvg/hd9var.map
           0 ./home
           0 ./home/lost+found
           0 ./home/guest
           0 ./home/ftp
         254 ./home/ftp/.profile
           0 ./home/ftp/bin
       18774 ./home/ftp/bin/ls
           0 ./home/ftp/etc
           0 ./home/ftp/pub
      150841 ./home/ftp/pub/aix-1-let.ps
     3404039 ./home/ftp/pub/aix-2-let.ps
     9210123 ./home/ftp/pub/aix-3-let.ps
     4690937 ./home/ftp/pub/aix-6-let.ps
     6512370 ./home/ftp/pub/aix-7-let.ps
.......... (Lines Removed)
The total size is 509575953 bytes.
The number of archived files is 37773.
```

This scrolls down the screen showing you all the files on the backup medium. If you want to show only the header information you can leave out the -T and -v flags.

Change to the /var directory and check present working directory.

```
# cd /var
# pwd
/var
```

List the contents of the current directory:

```
# ls -l
total 13
drwxrwxr-x   8 root     adm          512 Oct 22 09:14 adm
drwxr-xr-x   2 bin      bin          512 Aug 25 16:47 cifs
dr-xr-xr-x   3 bin      bin         1024 Aug 26 13:37 ifor
drwxrwxrwx   2 root     system       512 Oct 22 09:15 locks
drwx------   2 root     system       512 Aug 25 09:21 lost+found
drwxrwxrwx   2 bin      bin          512 Aug 25 09:23 msgs
drwxrwxrwx   2 bin      bin          512 Aug 25 09:23 news
drwxrwxrwx   2 bin      bin          512 Sep 21 16:40 preserve
```

```
dr-xr-x---   2 root     system       512 Aug 25 09:39 security
drwxrwxr-x  12 bin      bin          512 Sep 23 09:09 spool
drwxrwxrwt   2 bin      bin          512 Oct 27 14:28 tmp
```

Change directory to the root directory and check the present working directory:

```
# cd /
# pwd
/
```

Rewind the tape and start the restore of directory /var/dt. Notice the . (point) before the directory name; this is always needed when restoring from a `mksysb` backup:

```
# tctl -f /dev/rmt0 rewind
# restore -x -d -v -s4 -f/dev/rmt0.1 ./var/dt
New volume on /dev/rmt0.1:
Cluster size is 51200 bytes (100 blocks).
The volume number is 1.
The backup date is: Tue Oct 27 10:15:25 CST 1998
Files are backed up by name.
The user is root.
.......... (Lines Removed)
x          117 ./var/dt/Xerrors
x            5 ./var/dt/Xpid
x           44 ./var/dt/A:0-oActaa
x           44 ./var/dt/A:0-IdcsMa
x           44 ./var/dt/A:0-WqcsMa
x           44 ./var/dt/A:0-UzcsUa
x           44 ./var/dt/A:0-V7csUa
x           44 ./var/dt/A:0-kAcsUa
x           44 ./var/dt/A:0-YYcsUa
x           44 ./var/dt/A:0-Xoctia
.......... (Lines Removed)
The total size is 1065 bytes.
The number of restored files is 32.
```

The preceding is the information from the tape device during the restore operation listing all the files restored.

Change your directory to /var and list the contents of the /var directory.

```
# cd /var
# ls -l
total 14
drwxrwxr-x   8 root     adm          512 Oct 22 09:14 adm
drwxr-xr-x   2 bin      bin          512 Aug 25 16:47 cifs
drwxr-xr-x   4 bin      bin          512 Oct 29 10:26 dt
dr-xr-xr-x   3 bin      bin         1024 Aug 26 13:37 ifor
```

```
drwxrwxrwx   2 root     system       512 Oct 22 09:15 locks
drwx------   2 root     system       512 Aug 25 09:21 lost+found
drwxrwxrwx   2 bin      bin          512 Aug 25 09:23 msgs
drwxrwxrwx   2 bin      bin          512 Aug 25 09:23 news
drwxrwxrwx   2 bin      bin          512 Sep 21 16:40 preserve
dr-xr-x---   2 root     system       512 Aug 25 09:39 security
drwxrwxr-x  12 bin      bin          512 Sep 23 09:09 spool
drwxrwxrwt   2 bin      bin          512 Oct 27 14:28 tmp
```

Check if the directory /var/dt has been restored.

- `tar`

  The following command restores the directory and the directory contents using the `tar` command:

  ```
  tar -x -v -f /dev/rmt0 /var/dt
  ```

- `cpio`

  The following command restores the directory and the directory contents using the `cpio`. command:

  ```
  cpio -i -c -v -d -u -m -B < /dev/rmt0 "/var/dt/*"
  ```

- `restore`

  The next two commands shows additional ways to restore a directory and its contents using the `restore` command.

  The following shows how to restore the directory from a filename backup:

  ```
  restore -x -d -v -q -f /dev/rmt0 /var/dt
  ```

  The following shows how to restore the directory where a file system backup was done:

  ```
  restore -x -v -q -f /dev/rmt0 /var/dt
  ```

8.3.3 Errors on Restore, Incorrect Block Size

When you need to restore from tape, but the backup was made using an unknown block size, then you need to pipe `dd` into the `restore` command.

The error displayed is:

```
Media Read Error - I/O Error
```

The following is an example for the file name restore:

```
# dd if=/dev/rmt0 bs=51200 | restore -xvqf-
x      1062769 ./ausnames
x      1833056 ./backuplistand
57+0 records in.
```

```
57+0 records out.
```

or

```
restore -xvqf- </dev/rmt0
```

This is the example for the i-node restore:

```
dd if=/dev/rmt0 bs=51200 | restore -xvqmf-
```

or

```
restore -xvqmf- </dev/rmt0
```

8.3.4 Using the rmfs Command

The `rmfs` command removes a file system. You can use this command once you have restored a backup to clean up file systems that are no longer required, or unintentionally mounted during backup time. To run, enter:

```
rmfs userfs
```

8.4 Cloning Your System

A mksysb images enable you to clone one system image onto multiple target systems. The target systems might not contain the same hardware devices or adapters, require the same kernel (uniprocessor or microprocessor), or be the same hardware platform (rs6k, rspc, or chrp) as the source system. If you are installing a mksysb on a system it was not created on, use the procedure Cloning Your System.

Use this procedure to install a mksysb on a target system it was not created on. Be sure to boot from the product media appropriate for your system and at the same maintenance level of BOS as the installed source system that the mksysb was made on. For example, you can use BOS Version 4.2.1 product media with a mksysb from a BOS Version 4.2.1 system. This procedure is to be used when installing a backup tape to a different system.

After booting from product media, complete the following steps when the Welcome to the Base Operating System Installation and Maintenance screen is displayed.

1. Select the Start Maintenance Mode for System Recovery option.
2. Select the Install from a System Backup option.
3. Select the drive containing the backup tape and insert the media for that device. The system reads the media and begins the installation.

You will be prompted again for the BOS installation language, and the Welcome screen should be displayed. Continue with the Prompted

Installation, as cloning is not supported in nonprompted installations.

4. You will be prompted again for the BOS install language, and the Welcome screen is displayed. Continue with the Prompted Installation process, as cloning is not supported for Nonprompted Installations.

Notes

- Booting from tape product media is not supported on some rspc platform systems. When a backup tape is created on one of these systems, the mksysb command will display a message indicating that the system does not support tape boot. To determine what your platform system is, enter the following command:

  `bootinfo -p`

  or `lscfg -vp | grep Arch`

- If you are cloning from the product tape to restore a backup tape, create a diskette that contains a ./bosinst.data file with SWITCH_TO_PRODUCT_TAPE=yes in the control_flow stanza if this was not set prior to making the mksysb.
- If SWITCH_TO_PRODUCT_TAPE is set to yes, the system will prompt you to remove the mksysb media and insert the product

After the mksysb installation completes, the installation program automatically installs additional devices and the kernel (uniprocessor or microprocessor) on your system using the original product media you booted from. Information is saved in BOS installation log files. To view BOS installation log files, enter cd /var/adm/ras and view the devinst.log file in this directory.

If the source system does not have the correct passwords and network information, you may make modifications on the target system now. Also, some products ship device-specific files such as graPHIGS. If your graphics adapter is different on the target system, verify that the device-specific filesets for graphics-related LPPs are installed.

If the system you have cloned is using OpenGL or graPHIGS, there may be some device filesets from these LPPs that must be installed after a clone.

8.5 Creating a Duplicate Copy of a Diskette

The `dd` command reads the *InFile* parameter or standard input, performs any specified conversions, then copies the converted data to the *OutFile* parameter or standard output.

To make a duplicate copy of a diskette, you first use the `dd` command to copy the contents of the diskette into a temporary file. Once the temporary file has been created, use the `dd` command to copy the temporary file onto the /dev/fd0 device, thus, creating a duplicate of your diskette. The following commands demonstrate this:

```
# dd if=/dev/fd0 of=/tmp/ddcopy
2880+0 records in.
2880+0 records out.
# dd if=/tmp/ddcopy of=/dev/fd0
2880+0 records in.
2880+0 records out.
```

8.6 Duplicating a Magnetic Tape

The `tcopy` command copies magnetic tapes. Source and target file names are specified by the Source and Destination parameters. The `tcopy` command assumes that there are two tape marks at the end of the tape, and it ends when it finds the double file marks.

To copy from tape device to another, enter:

```
# tcopy /dev/rmt0 /dev/rmt1
tcopy: Tape File: 1; Records: 1 to 74; Size: 2097152.
tcopy: Tape File: 1; Record: 75; Size 1574912.
tcopy: File: 1; End of File after: 75 Records, 156764160 Bytes.
tcopy: The end of the tape is reached.
tcopy: The total tape length is 156764160 bytes.
```

The duplication of the tape cartridge is now complete.

8.7 Using the tctl Command to Take a Tape Device Off-Line

The `tctl` command delivers subcommands to a streaming tape device. If you do not specify the *Device* variable with the -f flag, the TAPE environment variable is used. If an online tape drive requires service and appears unresponsive, use the following command:

```
tctl -f /dev/rmt0 reset
```

The `reset` command sends a bus device reset (BDR) to the tape device. The BDR will only be sent if the device cannot be opened and is not busy. You will not receive any form of notification. Once complete, the system will return the cursor to a prompt.

8.8 rmt Special File Notes

The purpose of the device rmt is to provides access to the sequential-access bulk storage medium device driver.

Magnetic tapes are used primarily for backup, file archives, and other off-line storage. Tapes are accessed through the /dev/rmt0, ..., /dev/rmt255 special files. The r in the special file name indicates raw access through the character special file interface. A tape device does not lend itself well to the category of a block device. Thus, only character interface special files are provided.

In Table 31 is a list of the tape device special file characteristics; /dev/rmt* can be from /dev/rmt0 to /dev/rmt255.

Table 31. Tape Device Special File Characteristics

Special File Name	Rewind-on-Close	Retension-on-Open	Bytes per Inch
/dev/rmt*	Yes	No	Density setting #1
/dev/rmt*.1	No	No	Density setting #1
/dev/rmt*.2	Yes	Yes	Density setting #1
/dev/rmt*.3	No	Yes	Density setting #1
/dev/rmt*.4	Yes	No	Density setting #2
/dev/rmt*.5	No	No	Density setting #2
/dev/rmt*.6	Yes	Yes	Density setting #2
/dev/rmt*.7	No	Yes	Density setting #2

The following can be said about the characteristics shown:

- The values of density setting #1 and density setting #2 come from tape drive attributes that can be set using SMIT. Typically, density setting #1 is set to the highest possible density for the tape drive, while density setting #2 is set to a lower density. However, density settings are not required to follow this pattern.

- The density value (bytes per inch) is ignored when using a magnetic tape device that does not support multiple densities. For tape drives that do support multiple densities, the density value only applies when writing to the tape. When reading, the drive defaults to the density at which the tape is written.
- Older tape drives use a 512-byte block size. The 8mm tape drive uses a minimum block size of 1024 bytes. Using SMIT to lower the block size may waste space.

8.9 High Availability Cluster Multi-Processing

HACMP for AIX is an application solution that can link up to eight RS/6000 servers or SP nodes into highly available clusters. With the enhanced scalability feature, up to 16 SP nodes can be linked. Clustering servers or nodes enables parallel access to their data, which can help provide the redundancy and fault resilience required for business critical applications. HACMP includes graphical user interface-based tools to help install, configure, and manage your clusters in a highly productive manner.

HACMP is flexible in configuration and use. Uniprocessors, symmetric multiprocessors (SMPs) and SP nodes can all participate in highly available clusters. Micro Channel and PCI-based systems are supported under AIX. You can mix and match system sizes and performance levels as well as network adapters and disk subsystems to satisfy your application, network, and disk performance needs.

HACMP clusters can be configured in several modes for different types of processing requirements. Concurrent access mode suits environments where all of the processors must work on the same workload and share the same data at the same time. In a mutual takeover mode, the processors share the workload and back each other up. Idle standby allows one node to back up any of the other nodes in the cluster.

Whichever mode you choose, HACMP provides data access and backup plans to help optimize application execution and scalability while helping to guard against costly unplanned outages and down time. HACMP also enables server clusters to be configured for application recovery/restart to provide a measure of fault resilience for your business critical applications through redundancy.

Understanding HACMP is a lesson in fault tolerant systems. If you do not want to commit all the resources required for an HACMP installation, but you can still eliminate many of the potential exposures for system downtime by

adding redundancy to disk drives, adapter cards, network connections, and by implementing software RAS features, such as disk mirroring and system monitoring.

8.10 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. What is the purpose of the `mkszfile` command?

   A. It creates or updates the /image.data file.

   B. It reports the size of a file in bytes.

   C. It creates a bootable system backup.

   D. It creates/updates the /.fsdata.

2. After creating a tar archive on a tape and verifying that the backup was successful, a system administrator then inserts the tape into another machine to access the data and receives the following error:

   ```
   "Media Read Error - I/O Error"
   ```

   Which of the following is the most likely cause of the error?

   A. The blocksize or density setting is incorrect.

   B. There is a lack of disk space in the root file system.

   C. The tape is not read/writable.

   D. There is a bad cable on the tape drive.

3. A system administrator would like to restore the third image from a mksysb tape. In order to position the tape to the correct image, which of the following commands should be run?

   A. `tctl`

   B. `lsattr`

   C. `ffwd`

   D. `chdev`

4. The finance group at the Widget Company has just approved a new financial package that runs on an RS/6000. They will be converting their old data to the new system. Currently, they have 10 GB of data but will be growing to 18 GB with the new system because they want to maintain one year of history online. The new system they have ordered is an F50 with

128 MB of RAM, an SSA card, two 9.1 GB SSA, drives and a single FDDI card.

What would be the best addition to this system for redundancy?

1. One SSA card
2. Two 9.1 GB SSA disks
3. Error correcting RAM
4. Two additional processors

A. 1 and 2

B. 4 and 1

C. 4 and 2

D. 3 and 1

8.10.1 Answers

The following are the answers to the previous questions:

1. A
2. A
3. A
4. A

8.11 Exercises

Provided here are some exercises you may wish to perform:

1. Use `mksysb` to back up the volume group uservg.
2. Exclude file systems from a `mksysb` backup.
3. Design a sound backup schedule and strategy for your system.
4. Create a bootable system backup.
5. There are errors on restore and incorrect block size. Overcome this obstacle.
6. Retrieve a file from a `mksysb`, a `tar` backup, and a `cpio` backup.
7. Retrieve a directory from a `mksysb`, a `tar` backup, and a `cpio` backup.
8. Back up a current directory using `tar`.

9. What makes the `mkszfile` command so important?
10. Back up a single volume group.
11. Clone a system. Why use the `rmfs` command?
12. Make a copy of a diskette and then make a copy of a tape.
13. Position a mksysb backup at a the end of the third image.
14. The LED 243 error means what?

Chapter 9. System Resource Controller Administration

The System Resource Controller (SRC) provides a set of commands and subroutines to make it easier for the system manager and programmer to create and control subsystems. A subsystem is any program or process or set of programs or processes that is capable of operating independently or with a controlling system. A subsystem is designed as a unit to provide a designated function. A subserver is a program or process that belongs to a subsystem.

The SRC is designed to minimize the need for operator intervention. It provides a mechanism to control subsystem processes using a common command line and the C interface. This mechanism includes the following:

- Consistent user interface for start, stop, and status inquiries
- Logging of the abnormal termination of subsystems
- A notification program called at the abnormal system termination of related processes
- Tracing of a subsystem, a group of subsystems, or a subserver
- Support for control of operations on a remote system
- Refreshing of a subsystem (such as after a configuration data change)

The SRC is useful if you want a common way to start, stop, and collect status information on processes.

9.1 Starting the SRC

The System Resource Controller (SRC) is started during system initialization with a record for the /usr/sbin/srcmstr daemon in the /etc/inittab file. The default /etc/inittab file already contains such a record, so starting the SRC may be unnecessary. You can, if needed, start the SRC from the command line, a profile, or a shell script, but there are several reasons for starting it during initialization:

- Starting the SRC from the /etc/inittab file allows the `init` command to restart the SRC should it stop for any reason.
- The SRC is designed to simplify and reduce the amount of operator intervention required to control subsystems. Starting the SRC from any source other than the /etc/inittab file would be counter-productive to that goal.

- The default /etc/inittab file contains a record for starting the print scheduling subsystem (qdaemon) with the `startsrc` command. Typical installations have other subsystems started with `startsrc` commands in the /etc/inittab file as well. Since the `startsrc` command requires the SRC to be running, removing the srcmstr daemon from the /etc/inittab file would cause these `startsrc` commands to fail.

Refer to the manual page using the command `man srcmstr` for the configuration requirements to support remote SRC requests.

If the /etc/inittab file does not already contain a record for the srcmstr daemon, you can add one using the following procedure:

1. Make a record for the srcmstr daemon in the /etc/inittab file using the `mkitab` command. For example, to make a record identical to the one that appears in the default /etc/inittab file, enter:

   ```
   mkitab -i fbcheck srcmstr:2:respawn:/usr/sbin/srcmstr
   ```

   The -i fbcheck flag ensures that the record is inserted before all subsystems records.

2. Tell the `init` command to reprocess the /etc/inittab file by entering:

   ```
   telinit q
   ```

   When `init` revisits the /etc/inittab file, it processes the newly entered record for the srcmstr daemon and starts the SRC.

9.2 Restarting the SRC

Normally, you do not need to restart srcmstr. The default record in /etc/inittab for both AIX 4.3.2 and AIX 4.2.1 is shown in Table 32:

Table 32. Default scrmstr Record in the /etc/inittab File

Field	Value
Identifier	srcmstr
RunLevel	2
Action	respawn
Command	/usr/sbin/srcmstr

If the srcmstr daemon terminates abnormally, the respawn action specified in the /etc/inittab restarts the srcmstr daemon. The srcmstr daemon then determines which SRC subsystems were active during the previous invocation. The daemon reestablishes communication with these subsystems

(if it existed previously) and initializes a private kernel extension and the srcd daemon to monitor the subsystem processes. Note that the process ID is changed after srcmstr is terminated and restarted automatically as shown in Figure 81.

```
# ps -ef |grep srcmstr
    root  2650     1   0 09:59:48      -  0:00 /usr/sbin/srcmstr
    root 13922 11870   2 10:33:04  pts/2  0:00 grep srcmstr
# kill -9 2650
# ps -ef |grep srcmstr
    root  6246     1   0 10:33:09      -  0:00 /usr/sbin/srcmstr
    root 13700 11870   0 10:33:13  pts/2  0:00 grep srcmstr
# 
```

Figure 81. Restart of the srcmstr Daemon

However, if you have edited the /etc/inittab file adding the -r or -B flag to /usr/sbin/srcmstr, you have to use the command `init -q` to reexamine the /etc/inittab or reboot to make the new flags effective. The -r flag prevents srcmstr from responding to remote requests, and -B runs srcmstr in a pre-AIX 4.3.1 mode.

9.3 The startsrc Command

The `startsrc` command sends the System Resource Controller (SRC) a request to start a subsystem or a group of subsystems or to pass on a packet to the subsystem that starts a subserver.

If a start subserver request is passed to the SRC, and the subsystem to which the subserver belongs is not currently active, the SRC starts the subsystem and transmits the start subserver request to the subsystem.

The flags for the `startsrc` command are shown in Table 33.

Table 33. Flags for the startsrc Command

Flag	Description	Example
To start a subsystem		
-a argument	Specifies an argument string that is passed to the subsystem when the subsystem is executed.	`startsrc -s srctest -a "-D DEBUG"` This starts the srctest subsystem with "-D DEBUG" as two arguments to the subsystem.

Flag	Description	Example
-e Environment	Specifies an environment string that is placed in the subsystem environment when the subsystem is executed.	`startsrc -s srctest -e "TERM=dumb HOME=/tmp"` This starts the srctest subsystem with "TERM=dumb", "HOME=/tmp" in its environment to the subsystem.
-g Group	Specifies a group of subsystems to be started.	`startsrc -g nfs` This starts all the subsystems in the subsystem nfs group
-s Subsystem	Specifies a subsystem to be started.	`startsrc -s srctest`
To start either a subsystem or a subserver		
-h Host	Specifies the foreign host on which this start action is requested. The local user must be running as root. The remote system must be configured to accept remote System Resource Controller requests.	`startsrc -g nfs -h itsosmp` This starts all the subsystems in the subsystem nfs group on the itsosmp machine.
To start a subserver		
-t Type	Specifies that a subserver is to be started.	`startsrc -t tester` This sends a start subserver request to the subsystem that owns the tester subsystem.
-o Object	Specifies that a subserver object is to be passed to the subsystem as a character string. It is the subsystem's responsibility to determine the validity of the Object string.	`startsrc -o tester -p 1234` The subserver tester is passed as a character string to the subsystem with a PID of 1234.
-p SubsystemPID	Specifies a particular instance of the subsystem to which the start subserver request is to be passed.	`startsrc -t tester -p 1234` This starts the tester subserver that belongs to the srctest subsystem with a subsystem PID of 1234.

9.4 The syslogd Daemon

The syslog function on AIX is provided by the syslogd deamon. The syslogd daemon reads a datagram socket and sends each message line to a destination described by the /etc/syslog.conf configuration file. The syslogd daemon reads the configuration file when it is activated or when it receives a hangup signal.

9.4.1 Starting the syslogd Daemon

The syslogd daemon is started during system IPL by srcmstr. The stanza in ODM is shown as follows in Figure 82.

```
#odmget -q subsysname=syslogd SRCsubsys

SRCsubsys:
        subsysname = "syslogd"
        synonym = ""
        cmdargs = ""
        path = "/usr/sbin/syslogd"
        uid = 0
        auditid = 0
        standin = "/dev/console"
        standout = "/dev/console"
        standerr = "/dev/console"
        action = 2
        multi = 0
        contact = 3
        svrkey = 0
        svrmtype = 0
        priority = 20
        signorm = 0
        sigforce = 0
        display = 1
        waittime = 20
        grpname = "ras"
#
```

Figure 82. Syslogd Stanza in ODM

9.4.2 syslog Configuration File

The configuration file informs the syslogd daemon where to send a system message depending on the message's priority level and the facility that generated it.

If you do not use the -f flag to specify an alternate configuration file, the default configuration file /etc/syslog.conf file is used.

The syslogd daemon ignores blank lines and lines beginning with a # (pound sign).

Lines in the configuration file for the syslogd daemon contain a selector field and an action field separated by one or more tabs.

The selector field names a facility and a priority level. Separate facility names with a , (comma). Separate the facility and priority-level portions of the selector field with a . (period). Separate multiple entries in the same selector field with a ; (semicolon). To select all facilities, use an * (asterisk).

The action field identifies a destination (file, host, or user) to receive the messages. If routed to a remote host, the remote system will handle the message as indicated in its own configuration file. To display messages on a user's terminal, the destination field must contain the name of a valid, logged-in system user.

The last part of the default /etc/syslog.conf is shown in Figure 83.

```
# /etc/syslog.conf - control output of syslogd
#
#
# Each line must consist of two parts:-
#
# 1) A selector to determine the message priorities to which the
#    line applies
# 2) An action.
#
# The two fields must be separated by one or more tabs or spaces.
#
# format:
#
# <msg_src_list>                <destination>
#
# where <msg_src_list> is a semicolon separated list of <facility>.<priority>
# where:
#
# <facility> is:
#       * - all (except mark)
#       mark - time marks
#       kern,user,mail,daemon, auth,... (see syslogd(AIX Commands Reference))
#
# <priority> is one of (from high to low):
#       emerg/panic,alert,crit,err(or),warn(ing),notice,info,debug
#       (meaning all messages of this priority or higher)
#
# <destination> is:
#       /filename - log to this file
#       username[,username2...] - write to user(s)
#       @hostname - send to syslogd on this machine
#       * - send to all logged in users
#
# example:
# "mail messages, at debug or higher, go to Log file. File must exist."
# "all facilities, at debug and higher, go to console"
# "all facilities, at crit or higher, go to all users"
#  mail.debug           /usr/spool/mqueue/syslog
#  *.debug              /dev/console
#  *.crit                       *
#
```

Figure 83. Sample syslog Configuration File

If you decide to capture the warning messages from all users in the /var/spool/syslog file, you should do the following:

1. Add the following line to the /etc/syslog.conf file as the last line of the file.

   ```
   *.warning            /var/spool/syslog
   ```

2. Create the /var/spool/syslog file.

   ```
   touch /var/spool/syslog
   ```

3. Change the permission bits of /var/spool/syslog so that all users are allowed to write warning messages to this file.

   ```
   chmod 666 /var/spool/syslog
   ```

4. Refresh the syslogd daemon to make the update to syslog configuration file effective.

   ```
   refresh -s syslogd
   ```

9.4.3 Recycling and Refreshing the syslogd Daemon

The syslogd daemon reads the configuration file when it is activated or when it receives a hangup signal. A refresh keeps the current process ID and is a less intrusive method of reading the configuration file. A recycle is useful when you feel there is a problem with the service and a complete restart is required. You can recycle the syslogd daemon by stopping and then starting it.

1. `stopsrc -s syslogd`
2. `startsrc -s syslogd`

Alternatively, you can refresh the syslogd daemon by sending a HUP signal.

1. `ps -ef |grep syslogd`

   Note the PID of the syslogd process, for example, 5682.

2. `kill -1 5682`

9.4.4 Collecting syslog Data from Multiple Systems

The syslogd daemon logs messages received from remote hosts unless you use the -r flag to suppress it.

In the /etc/syslog.conf of the remote hosts, instead of specifying the full path name of the file for logging message for the destination part, put in @Host where Host is the hostname of the remote system.

9.5 Refreshing a Daemon

Use the `refresh` command to tell a System Resource Controller (SRC) resource, such as a subsystem or a group of subsystems, to refresh itself.

The prerequisites for using the `refresh` command are:

- The SRC must be running.
- The resource you want to refresh must not use the signals communications method.
- The resource you want to refresh must be programmed to respond to the refresh request.

The `refresh` command sends the System Resource Controller a subsystem refresh request that is forwarded to the subsystem. The refresh action is subsystem-dependent.

You have started the Lotus Domino Go Webserver using the command:

```
startsrc -s httpd
```

To allow users to open a homepage, index.html, in a new directory, /newdir, you have added a directory mapping in the /etc/httpd.conf file:

```
pass          /*          /newdir/*
```

To refresh the Web server, enter:

```
refresh -s httpd
```

After this, the users will be able to access the new homepage by entering the following URL in their Web browser:

```
http://<server_name>[:port_number]/newdir/index.html
```

9.6 The cron Daemon

The cron daemon runs shell commands at specified dates and times. The following event types are scheduled by the cron daemon:

- `crontab` command events
- `at` command events
- `batch` command events
- sync subroutine events
- `ksh` command events
- `csh` command events

The way these events are handled is specified in the /var/adm/cron/queuedefs file.

Regularly scheduled commands can be specified according to the instructions contained in the crontab files. You can submit your crontab file with the `crontab` command. Use the `at` command to submit commands that are to be run only once. Because the cron daemon never exits, it should be run only once.

The cron daemon examines crontab files and `at` command files only when the cron daemon is initialized. When you make changes to the crontab files using

the `crontab` command, a message indicating the change is sent to the cron daemon. This eliminates the overhead of checking for new or changed files at regularly scheduled intervals.

When the TZ environment variable is changed, either with the `chtz` command, a Web-based System Management application, or through SMIT, the cron daemon must be restarted. This enables the cron daemon to use the correct timezone and summer time change information for the new TZ environment variable.

The cron daemon creates a log of its activities in the /var/adm/cron/log file.

9.6.1 Crontab File Record Format

A crontab file contains entries for each cron job. Entries are separated by newline characters. Each crontab file entry contains six fields separated by spaces or tabs in the following form:

```
minute  hour  day_of_month  month  weekday  command
```

These fields accept the following values:

minute	0 through 59
hour	0 through 23
day_of_month	1 through 31
month	1 through 12
weekday	0 through 6 for Sunday through Saturday
command	a shell command

You must specify a value for each field. Except for the command field, these fields can contain the following:

- A number in the specified range. To run a command in May, specify 5 in the month field.
- Two numbers separated by a dash to indicate an inclusive range. To run a cron job on Tuesday through Friday, place 2-5 in the weekday field.
- A list of numbers separated by commas. To run a command on the first and last day of a month, you would specify 1,31 in the day_of_month field.
- An * (asterisk), meaning all allowed values. To run a job every hour, specify an asterisk in the hour field.

Note

Any character preceeded by a backslash (including the %) causes that character to be treated literally.

For example, if you have written a script fullbackup stored in the /root directory, and you want schedule it to run at 1 am on the 15th of every month, use the `crontab -e` command to add an entry as follows:

```
0 1 15 * * /fullbackup
```

Note

The execution permission bit of the /fullbackup file must be on.

9.6.2 Housekeeping

When you have logged in as root or used the `su` command to become root, the `crontab -l` command shows that these are three commented entries in the crontab file. They are:

- `#0 3 * * * /usr/sbin/skulker`
- `#45 2 * * 0 /usr/lib/spell/compress`
- `#45 23 * * * ulimit 5000; /usr/lib/smdemon.cleanu > /dev/null`

These are housekeeping jobs that you can enable to clean up your system. Use the `crontab -e` command to remove the `#` mark in column 1 to enable the jobs. Also, you may change the time when you want the job to run. A sample crontab file is shown in Figure 84:

```
# crontab -l
# @(#)08       1.15.1.3  src/bos/usr/sbin/cron/root, cmdcntl, bos430, 9737A_430
 2/11/94 17:19:47
# IBM_PROLOG_BEGIN_TAG
# This is an automatically generated prolog.
#
# bos430 src/bos/usr/sbin/cron/root 1.15.1.3
#
# Licensed Materials - Property of IBM
#
# (C) COPYRIGHT International Business Machines Corp. 1989,1994
# All Rights Reserved
#
# US Government Users Restricted Rights - Use, duplication or
# disclosure restricted by GSA ADP Schedule Contract with IBM Corp.
#
# IBM_PROLOG_END_TAG
#
# COMPONENT_NAME: (CMDCNTL) commands needed for basic system needs
#
# FUNCTIONS:
#
# ORIGINS: 27
#
# (C) COPYRIGHT International Business Machines Corp. 1989,1994
# All Rights Reserved
# Licensed Materials - Property of IBM
#
# US Government Users Restricted Rights - Use, duplication or
# disclosure restricted by GSA ADP Schedule Contract with IBM Corp.
#
#0 3 * * * /usr/sbin/skulker
#45 2 * * 0 /usr/lib/spell/compress
#45 23 * * * ulimit 5000; /usr/lib/smdemon.cleanu > /dev/null
0 11 * * * /usr/bin/errclear -d S,O 30
0 12 * * * /usr/bin/errclear -d H 90
0 4 * * * /usr/bin/rmxcred -d 4 1>/dev/null 2>/dev/null
# 
```

Figure 84. Sample crontab File

9.6.2.1 The skulker Command

The `skulker` command is a command file for periodically purging obsolete or unneeded files from file systems. Candidate files include files in the /tmp directory, files older than a specified age, a.out files, core files, or ed.hup files.

The `skulker` command is normally invoked daily, often as part of an accounting procedure run by the `cron` command during off-peak periods. Modify the `skulker` command to suit local needs following the patterns shown in the distributed version. System users should be made aware of the criteria for automatic file removal.

The `find` command and the `xargs` command form a powerful combination for use in the `skulker` command. Most file selection criteria can be expressed conveniently with find expressions. The resulting file list can be segmented and inserted into `rm` commands using the `xargs` command to reduce the overhead that would result if each file were deleted with a separate command.

Note

Because the `skulker` command is run by a root user and its whole purpose is to remove files, it has the potential for unexpected results. Before installing a new `skulker` command, test any additions to its file removal criteria by running the additions manually using the `xargs -p` command. After you have verified that the new `skulker` command removes only the files you want removed, you can install it.

To enable the `skulker` command, you should use the `crontab -e` command to remove the comment statement by deleting the # (pound sign) character from the beginning of the /usr/sbin/skulker line in the /var/spool/cron/crontabs/root file.

9.6.2.2 The /usr/lib/spell/compress Command

This is *not* the AIX `compress` command. The `/usr/lib/spell/compress` command is a shell script to compress the spell program log.

To enable the `/usr/lib/spell/compress` command, you should use the `crontab -e` command to remove the comment statement by deleting the # (pound sign) character from the beginning of the /usr/lib/spell/compress line in the /var/spool/cron/crontabs/root file.

The script is shown in Figure 85:

```
# cat /usr/lib/spell/compress
#!/bin/bsh
# @(#)60        1.5  src/cmdtext/usr/bin/spell/compress.sh, cmdtext, cmdtext430,
 9737A_430 5/17/91 10:04:52
#
# COMPONENT_NAME: (CMDTEXT) Text Formatting Services
#
# FUNCTIONS:
#
# ORIGINS: 3
#
#       compress - compress the spell program log

trap 'rm -f /usr/tmp/spellhist;exit' 1 2 3 15
echo "COMPRESSED `date`" > /usr/tmp/spellhist
grep -v ' ' /usr/lib/spell/spellhist | sort -fud >> /usr/tmp/spellhist
cp /usr/tmp/spellhist /usr/lib/spell
rm -f /usr/tmp/spellhist
# 
```

Figure 85. /usr/lib/spell/compress Script

This script removes all duplicated words in the /usr/lib/spell/spellhist file. This file is updated when the users invoke the `spell` command.

9.6.2.3 The /usr/lib/smdemon.cleanu Command

The `smdemon.cleanu` command is a shell procedure that cleans up the `sendmail` command queue and maintains the /var/spool/mqueue/log file.

To enable the `smdemon.cleanu` command, you must remove the comment statement by deleting the # (pound sign) character from the beginning of the smdemon.cleanu line in the /var/spool/cron/crontabs/root file. If the /var/spool/mqueue directory does not exist, do not change the /var/spool/cron/crontabs/root file.

Be careful that the average size of a log file for each smdemon.cleanu session multiplied by the number of log files does not use more space than you need. You can arrange the number of log files to suit your needs.

Note

The `smdemon.cleanu` command is not usually entered on the command line. The command is executed by the cron daemon.

9.7 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. A system administrator would like to collect a log file of su activity on all hosts across a network. The central logfile will reside on host mars. The syslog daemon is already operational on host mars. Which of the following is the first step in accomplishing this task?

   A. Edit the /var/adm/sulog file on all hosts except mars adding the line:

   ```
   remote:mars
   ```

   B. Edit the /etc/syslog.conf file on all hosts except mars adding the line:

   ```
   auth.debug @mars
   ```

   C. Edit the /var/adm/syslog file on all hosts except mars adding the line:

   ```
   sulog = mars
   ```

   D. Edit the /etc/security/user file on all hosts except mars adding the following line to the default stanza:

   ```
   sulog = mars
   ```

2. An overwrite installation has just been completed in order to bring the machine up to the latest AIX version. Which of the following is the next step to take in order to enable operation of skulker?

   A. Run the command: `startsrc -s skulker`

   B. Run the command: `chitab "skulker:2:wait:/etc/rc.skulker"`

   C. Remove the comment from the skulker entry of the root crontab

   D. Remove the comment from the skulker entry in the inetd.conf and refresh inetd.

9.7.1 Answers

The following are the answers to the previous questions:

1. B
2. C

9.8 Exercises

Provided here are some exercises you may wish to perform:

1. What is needed to restart the SRC in AIX 4.3.2 or AIX 4.2.1? Is a reboot needed? Can it be done by refresh or other commands?
2. What is the `startsrc` command and the use of the major flags?
3. Start the syslog and examine the results.
4. What is the syslog configuration file? What should be done to refresh the daemon?
5. Collect syslog data from many systems.
6. Refresh the syslogd daemon to pick up modifications.
7. Refresh a daemon.
8. Explain the configuration file for cron jobs.
9. Enable the skulker, or other commented daemons.

Chapter 10. Network Administration

A network is the combination of two or more computers and the connecting links between them. A physical network is the hardware (equipment such as adapter cards, cables, and concentrators) that makes up the network. The software and the conceptual model make up the logical network.

You will find a few important aspects of administrating TCP/IP on the system in this section. Note that this does not present the full scope of network administration.

10.1 Network Startup at Boot Time

At IPL time, the /etc/inittab will start /etc/rc.tcpip after starting the SRC. If you have installed the IBM AIX SNA Manager/6000 (program number 5765-233), /etc/inittab will start SNA too.

The /etc/rc.tcpip file is a shell script that, when executed, uses SRC commands to initialize selected daemons. It can also be executed at any time from the command line.

Most of the daemons that can be initialized by the rc.tcpip file are specific to TCP/IP. These daemons are:

- inetd (started by default)
- gated
- routed
- named
- timed
- rwhod

Note

Running the gated and routed daemons at the same time on a host may cause unpredictable results.

There are also daemons specific to the base operating system or to other applications that can be started through the rc.tcpip file. These daemons are:

- lpd
- portmap

- sendmail
- syslogd

The syslogd daemon is started by default.

10.2 Stopping and Restarting TCP/IP Daemons

The subsystems started from rc.tcpip can be stopped using the `stopsrc` command and restarted using the `startsrc` command.

10.2.1 Stopping TCP/IP Daemons Using /etc/tcp.clean Command

There is a script, /etc/tcp.clean, that you can use to stop the TCP/IP daemons. It will stop the following daemons and remove the /etc/locks/lpd TCP/IP lock files:

- ndpd-host
- lpd
- routed
- gated
- sendmail
- inetd
- named
- timed
- rwhod
- iptrace
- snmpd
- rshd
- rlogind
- telnetd
- syslogd

Note that the script /etc/tcp.clean does not stop the portmap and nfsd daemons. If you want to stop the portmap and the nfsd daemons, use the `stopsrc -s portmap` and the `stopsrc -s nfsd` commands. The execution bit of this /etc/tcp.clean file is not on by default. You will have to invoke it by issuing:

```
sh /etc/tcp.clean
```

10.2.2 Restarting TCP/IP Daemons

Invoke the `/etc/rc.tcpip` command to restart the TCP/IP daemons. Alternatively, you can use the `startsrc -s` command to start individual TCP/IP daemons.

Note

Do *not* restart TCP/IP daemons using the command:

```
startsrc -g tcpip
```

It will start all subsystems defined in the ODM for the tcpip group, which includes both routed and gated.

10.3 System Boot without Starting rc.tcpip

TCP/IP is a peer-to-peer, connection-oriented protocol. There are no master/slave relations. The applications, however, use a client/server model for communications.

Removing the rc.tcpip entry in /etc/inittab means that you are not starting any server applications during IPL.

Note

If you have a graphic console, make sure you also remove the rc.dt and rc.tcpip entries in the /etc/inittab file. Otherwise, your console will hang when you login. Unless you have an ASCII terminal connected to the serial port, there is no way you can recover since you will not be able to communicate with the machine through the `telnet` or `rlogin` commands with no TCP/IP server application started.

Without the server applications started, you will not be able to `telnet` or `ftp` to this machine from another host.

However, as long as you have not brought down the network interface, you can still utilize the client network services. You can still `ping` other hosts, you can still `telnet` to other hosts, and you can still `ftp` to other hosts.

The `ping` command sends an Internet Control Message Protocol (ICMP) ECHO_REQUEST to obtain an ICMP ECHO_RESPONSE from a host and does not need any server application. Therefore, even without starting any server application, the machine will still respond to a `ping` request from other hosts.

10.4 The inetd Daemon

The /usr/sbin/inetd daemon provides Internet service management for a network. This daemon reduces system load by invoking other daemons only when they are needed and by providing several simple Internet services internally without invoking other daemons.

10.4.1 Starting and Refreshing inetd

When the daemon starts, it reads its configuration information from the file specified in the Configuration File parameter. If the parameter is not specified, the inetd daemon reads its configuration information from the /etc/inetd.conf file. Once started, the inetd daemon listens for connections on certain Internet sockets in the /etc/inetd.conf and either handles the service request itself or invokes the appropriate server once a request on one of these sockets is received.

The /etc/inetd.conf file can be updated by using the System Management Interface Tool (SMIT), the System Resource Controller (SRC), or by editing the /etc/inetd.conf.

If you change the /etc/inetd.conf using SMIT, then the inetd daemon will be refreshed automatically and will read the new /etc/inetd.conf file. If you change the file using an editor, run the `refresh -s inetd` or `kill -1 InetdPID` commands to inform the inetd daemon of the changes to its configuration file. There will not be any message if you use the `kill -1` command as shown in Figure 86.

```
# refresh -s inetd
0513-095 The request for subsystem refresh was completed successfully.
# ps -ef |grep inetd
    root 17840  2900   0 09:17:31      -  0:00 /usr/sbin/inetd
    root 20606 20016   1 09:19:14  pts/2  0:00 grep inetd
# kill -1 17840
# ps -ef |grep inetd
    root 17482 20016   2 09:19:37  pts/2  0:00 grep inetd
    root 17840  2900   0 09:17:31      -  0:00 /usr/sbin/inetd
# 
```

Figure 86. Refreshing the inetd Daemon using Refresh or Kill

10.4.2 Subservers Controlled by inetd

The inetd daemon is a subsystem that controls the following daemons (subservers):

- comsat daemon
- ftpd daemon
- fingerd daemon
- rlogind daemon
- rexecd daemon
- rshd daemon
- talkd daemon
- telnetd daemon
- tftpd daemon
- uucpd daemon

The ftpd, rlogind, rexecd, rshd, talkd, telnetd, and uucpd daemons are started by default. The tftpd, fingerd, and comsat daemons are not started by default.

To start any one of them, remove the # sign in column one of the respective entry in the /etc/inetd.conf file. You can check the details of subservers started in inetd by using the `lssrc -ls` command as shown in Figure 87 on page 242.

```
# lssrc -ls inetd
Subsystem         Group            PID     Status
 inetd            tcpip            17840   active

Debug         Not active

Signal        Purpose
 SIGALRM      Establishes socket connections for failed services.
 SIGHUP       Rereads the configuration database and reconfigures services.

 SIGCHLD      Restarts the service in case the service ends abnormally.

Service       Command                  Description              Status
 xmquery      /usr/bin/xmservd         xmservd -p3              active
 ttdbserver   /usr/dt/bin/rpc.ttdbserver rpc.ttdbserver 100083 1  active
 cmsd         /usr/dt/bin/rpc.cmsd     cmsd 100068 2-5          active
 dtspc        /usr/dt/bin/dtspcd       /usr/dt/bin/dtspcd       active
 time         internal                                          active
 daytime      internal                                          active
 discard      internal                                          active
 echo         internal                                          active
 time         internal                                          active
 daytime      internal                                          active
 chargen      internal                                          active
 discard      internal                                          active
 pcnfsd       /usr/sbin/rpc.pcnfsd     pcnfsd 150001 1-2        active
 sprayd       /usr/lib/netsvc/spray/rpc.sprayd sprayd 100012 1          active
 rwalld       /usr/lib/netsvc/rwall/rpc.rwalld rwalld 100008 1          active
 rusersd      /usr/lib/netsvc/rusers/rpc.rusersd rusersd 100002 1-2       active
 rstatd       /usr/sbin/rpc.rstatd     rstatd 100001 1-3        active
 ntalk        /usr/sbin/talkd          talkd                    active
 klogin       /usr/sbin/krlogind       krlogind                 active
 login        /usr/sbin/rlogind        rlogind                  active
 kshell       /usr/sbin/krshd          krshd                    active
 shell        /usr/sbin/rshd           rshd                     active
 telnet       /usr/sbin/telnetd        telnetd                  active
 ftp          /usr/sbin/ftpd           ftpd                     active
# 
```

Figure 87. Subservers Started in inetd

10.4.3 Stopping inetd

Use the command `stopsrc -s inetd` to stop the inetd daemon as shown in Figure 88.

```
# stopsrc -s inetd
0513-044 The stop of the /usr/sbin/inetd Subsystem was completed successfully.
# 
```

Figure 88. Stopping inetd

When the inetd daemon is stopped, the previously started subservers processes are not affected. However, new service requests for the subservers can no longer be satisfied. If you try to `telnet` or `ftp` to the server with inetd down, you will see messages as shown in Figure 89.

```
$ telnet sv1166f
Trying...
telnet: connect: A remote host refused an attempted connect operation.
$ ftp sv1166f
ftp: connect: A remote host refused an attempted connect operation.
ftp> bye
$
```

Figure 89. Telnet and FTP when inetd at Server is Down

In other words, though existing sessions are not affected when the inetd daemon is stopped. No new telnet and ftp session can be established without restarting the inetd daemon first.

10.5 The Portmap Daemon

The portmap daemon converts remote procedure call (RPC) program numbers into Internet port numbers.

When an RPC server starts up, it registers with the portmap daemon. The server tells the daemon which port number it is listening to and which RPC program numbers it serves. Thus, the portmap daemon knows the location of every registered port on the host and which programs are available on each of these ports.

A client consults the portmap daemon only once for each program the client tries to call. The portmap daemon tells the client which port to send the call to. The client stores this information for future reference.

Since standard RPC servers are normally started by the inetd daemon, the portmap daemon must be started before the inetd daemon is invoked.

Note

If the portmap daemon is stopped or comes to an abnormal end, all RPC servers on the host must be restarted.

The nfsd is a common RPC server.

10.6 Host Name Resolution

TCP/IP provides a naming system that supports both flat and hierarchical network organizations so that users can use meaningful, easily remembered names instead of Internet addresses.

In flat TCP/IP networks, each machine on the network has a file (/etc/hosts) containing the name-to-Internet-address mapping information for every host on the network.

When TCP/IP networks become very large, as on the Internet, naming is divided hierarchically. Typically, the divisions follow the network's organization. In TCP/IP, hierarchical naming is known as the domain name system (DNS) and uses the DOMAIN protocol. The DOMAIN protocol is implemented by the named daemon in TCP/IP.

The default order in resolving host names is:

1. BIND/DNS (named)
2. Network Information Service (NIS)
3. Local /etc/hosts file

The default order can be overwritten by creating the configuration file, /etc/netsvc.conf and specifying the desired order. Both the default and /etc/netsvc.conf can be overwritten with the environment variable NSORDER.

You can override the order by creating the /etc/netsvc.conf file with an entry. If /etc/netsvc.conf does not exist, it will be just like you have the following entry:

```
hosts = bind,nis,local
```

You can override the order by changing the NSORDER environment variable. If it is not set, it will be just like you have issued the command:

```
export NSORDER=bind,nis,local
```

10.6.1 The /etc/resolv.conf File

The /etc/resolv.conf file defines Domain Name Protocol (DOMAIN) name-server information for local resolver routines. If the /etc/resolv.conf file does not exist, then BIND/DNS is considered to be not set up or running and therefore, not available. The system will attempt name resolution using the default paths, the /etc/netsvc.conf file, or the NSORDER environment variable.

A sample /etc/resolv.conf file is shown in Figure 90 on page 245.

```
# cat /etc/resolv.conf
nameserver      9.3.1.74
domain  itsc.austin.ibm.com
search  itsc.austin.ibm.com austin.ibm.com
#
```

Figure 90. Sample /etc/resolv.conf File

In this case, there is only one name server defined, with an address of 9.3.1.74. The system will query this domain name server for name resolution. The default domain name to append to names that do not end with a . (period) is itsc.austin.ibm.com. The search entry defines the list of domains to search when resolving a name; in the above example, they are itsc.austin.ibm.com and austin.ibm.com.

10.6.2 /etc/resolv.conf Related Problems

When you have problems getting a host name resolved, and you are using a name server, you should:

1. Verify that you have a resolv.conf file specifying the domain name and Internet address of a name server.

   Change the address of the `nameserver` entry shown in Figure 90 from 9.3.1.74 to 9.3.1.124. If you try to access a host by name, using the `ping sv1166a` command, that is not defined in the /etc/hosts, you will get an error message:

   ```
   0821-062 ping: host name sv1166a NOT FOUND
   ```

   Next, put back 9.3.1.74 as the nameserver. This time, add the domain name test.domain.com ahead of itsc.austin.ibm.com and austin.ibm.com. As test.domain.com does not exist, you will get the same `0821-062 ping: host name sv1166a NOT FOUND` message when the Time-to-live (TTL) expires if you issue the same `ping sv1166a` command.

2. Verify that the local name server is up by issuing the `ping` command with the IP address of the name server (found in the local resolv.conf file).

3. If the local name server is up, verify that the named daemon on your local name server is active by issuing the `lssrc -s named` command on the name server.

4. If you are running the syslogd daemon, there could be error messages logged. The output for these messages is defined in the /etc/syslog.conf file.

If these steps do not identify the problem, look at the name server host.

10.7 New Adapter Considerations

Changing network adapters in a machine may require additional configuration steps after the basic hardware installation. Consider the following tasks as the additional steps required to configure a new adapter.

1. If you missed the informational messages from the `cfgmgr` command invoked during system boot, you should invoke the command again to check if the required device-dependent software is missing.
2. Install the required device software, if needed using the `smitty devices` command.
3. Invoke the `diag -a` command to confirm that the new adapter resource is added in the hardware configuration.
4. Rerun `cfgmgr`.
5. Ensure that the adapter is available on the system by invoking the `lsdev -Cl ent0` command.
6. Obtain the IP address and netmask from your network architect.
7. Configure the network interface using the SMIT fastpath `smit inet`. Do not use `smit mktcpip`. It is only used for configuring TCP/IP for the first time.
8. Enable IP forwarding if the machine is connected to two networks.
9. Add a route to those systems that need access from any private networks.

10.8 Configuring a Network Interface Using SMIT

The SMIT fastpath command used to configure TCP/IP is `smit tcpip`. You can configure a network interface using the fast path `smit inet`. Check whether the en0 interface exists by selecting **List All Network Interfaces**. If en0 does not exist, select **Add a Network Interface**, and then select **Add a Standard Ethernet Network Interface**. You should see a panel as show in Figure 91 on page 247.

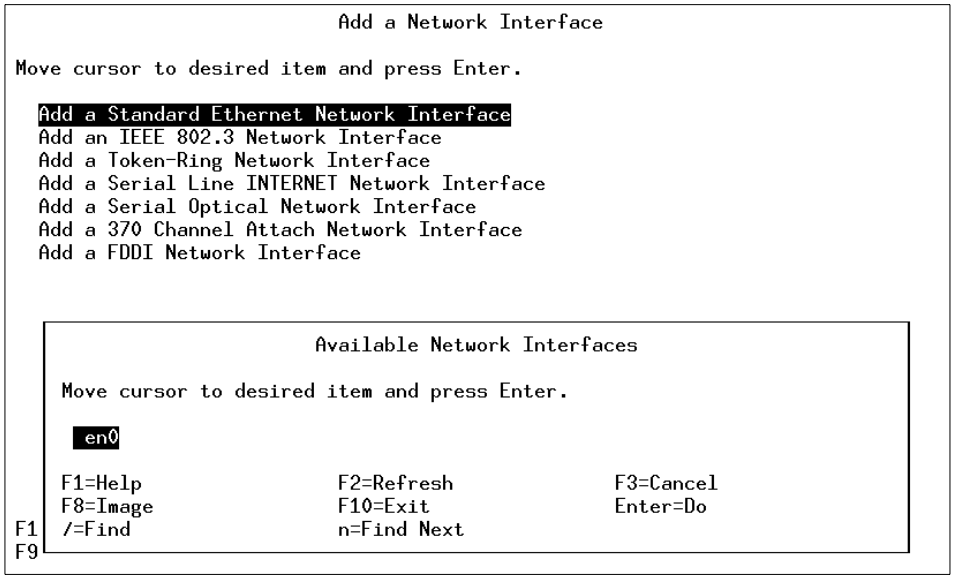

Figure 91. Available Network Interfaces

Press **Enter** to select en0 and fill in the following dialog screen.

Choose the interface that you need to configure and fill in the necessary information. A sample screen is shown in Figure 92 on page 248.

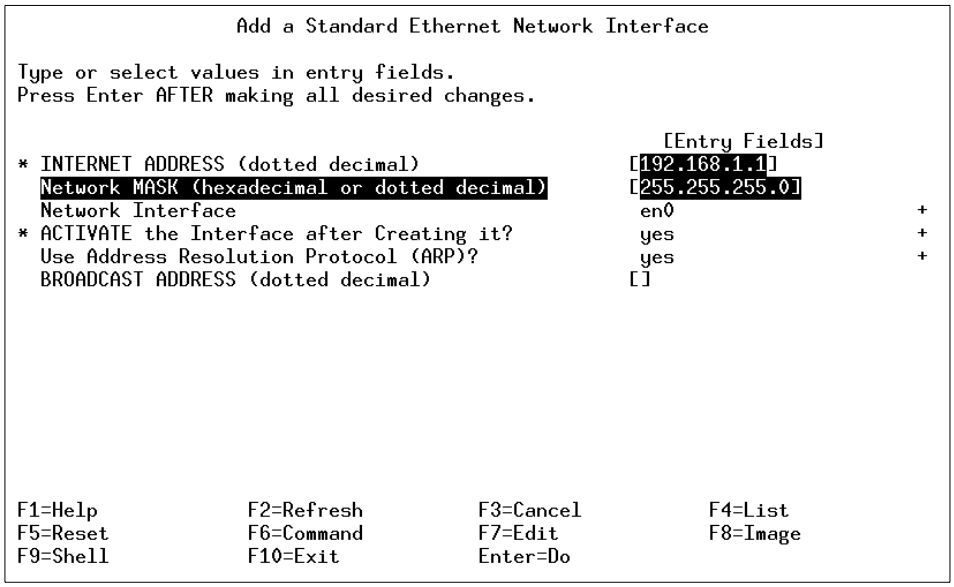

Figure 92. Add a Standard Ethernet Network Interface

On completion of adding the standard Ethernet network interface, you should see a message `en0 Available`.

If en0 already exists, select **Change / Show Characteristics of a Network Interface**. The SMIT fastpath is `smit chinet`. A sample screen is shown in Figure 93 on page 249.

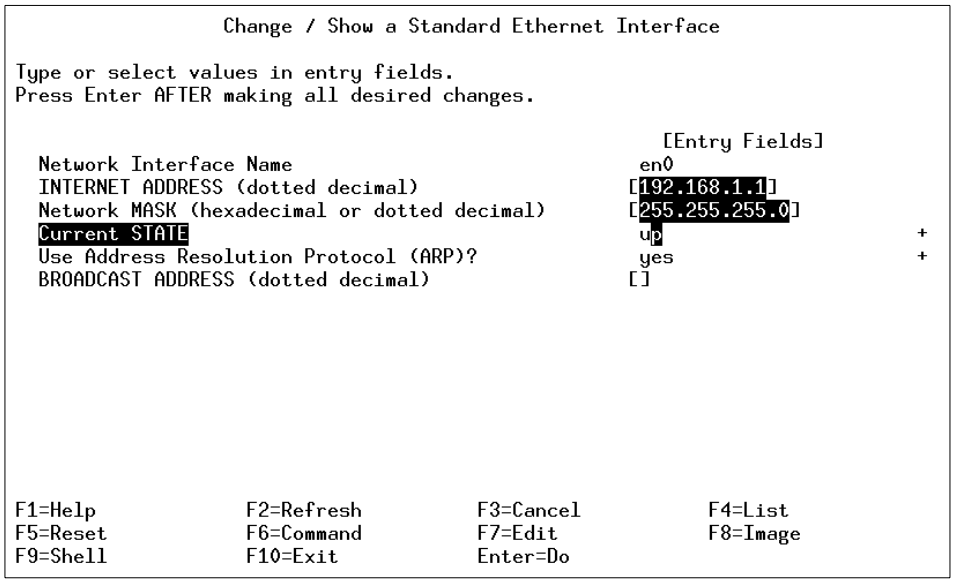

Figure 93. Change/Show a Standard Ethernet Interface

On completion of changing the standard Ethernet inferface, you should see a message that the en0 interface has been changed.

10.9 Enabling IP Forwarding

To allow other systems to access a private network through a machine containing two network adapters, you must enable IP forwarding. This system will now act as a gateway between network A and network B.

ipforwarding is a runtime attribute. The default value of 0 (zero) prevents forwarding of IP packets when they are not for the local system. A value of 1 (one) enables forwarding. Enable IP forwarding using the command:

```
no -o ipforwarding=1
```

This setting will be lost following a system reboot.

10.10 Adding Network Route

For those systems that need to access a private network, use the SMIT fastpath `smit route` or `smit mkroute` to add a route to the private network through the gateway between two networks. A sample of `smit mkroute` is shown in Figure 94 on page 250.

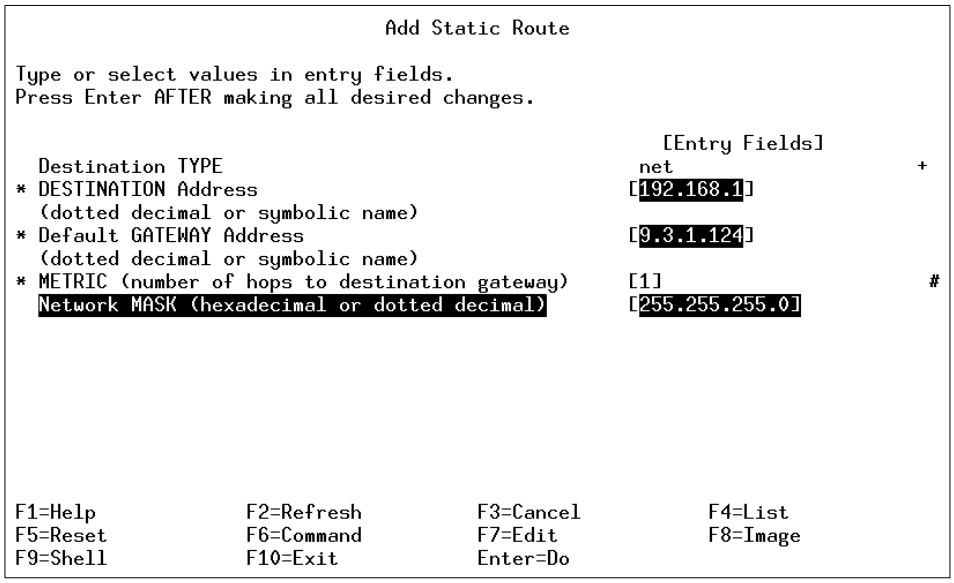

Figure 94. Adding a Route Using smit mkroute

Instead of using SMIT, you can also use the command:

```
route add -net 192.168.1 -netmask 255.255.255.0 9.3.1.124
```

The procedure shown in Figure 95 illustrates:

- A host cannot access the IP addresses 192.168.1.1 and 192.168.1.2.
- A route is added using the `route add` command specifying that 9.3.1.124 should be used as the gateway to the network 192.168.1.
- The `traceroute` command shows the route taken to reach both 192.168.1.1 and 192.168.1.2.

```
# ping 192.168.1.1
PING 192.168.1.1: (192.168.1.1): 56 data bytes
^C
----192.168.1.1 PING Statistics----
2 packets transmitted, 0 packets received, 100% packet loss
# ping 192.168.1.2
PING 192.168.1.2: (192.168.1.2): 56 data bytes
^C
----192.168.1.2 PING Statistics----
2 packets transmitted, 0 packets received, 100% packet loss
# ping 9.3.1.124
PING 9.3.1.124: (9.3.1.124): 56 data bytes
64 bytes from 9.3.1.124: icmp_seq=0 ttl=255 time=1 ms
64 bytes from 9.3.1.124: icmp_seq=1 ttl=255 time=1 ms
^C
----9.3.1.124 PING Statistics----
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 1/1/1 ms
# route add -net 192.168.1 -netmask 255.255.255.0 9.3.1.124
9.3.1.124 net 192.168.1: gateway 9.3.1.124
# traceroute 192.168.1.2
trying to get source for 192.168.1.2
source should be 9.3.1.33
traceroute to 192.168.1.2 (192.168.1.2) from 9.3.1.33 (9.3.1.33), 30 hops max
outgoing MTU = 1492
 1  192.168.1.2 (192.168.1.2)  13 ms  2 ms  2 ms
# traceroute 192.168.1.1
trying to get source for 192.168.1.1
source should be 9.3.1.33
traceroute to 192.168.1.1 (192.168.1.1) from 9.3.1.33 (9.3.1.33), 30 hops max
outgoing MTU = 1492
 1  sv1166f.itsc.austin.ibm.com (9.3.1.124)  13 ms  2 ms  2 ms
 2  192.168.1.1 (192.168.1.1)  5 ms  4 ms  3 ms
# 
```

Figure 95. Adding a Route Using the route add Command

10.11 Changing the IP Address Using SMIT

If you are moving your machine from one network segment to another and need to change IP addresses, use `smit mktcpip` the same way as the first time you configured TCP/IP. You may need to change the hostname, IP address, and the default gateway address. A sample screen is as shown in Figure 96 on page 252.

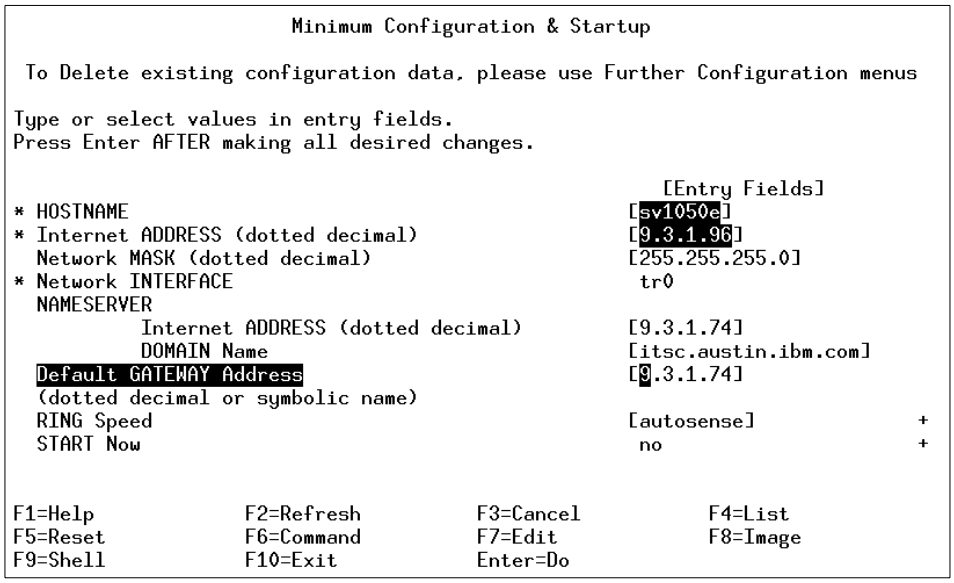

Figure 96. Changing the IP Address Using SMIT

Note

Do not perform this task in a Telnet session as you will lose your connection when the change is made.

If you are not moving across network segments and simply want to change the IP address, you can change the field START Now shown in Figure 96 to yes. This will start the TCP/IP daemons automatically or refresh them if they are already started.

10.12 Creating an IP Alias

Suppose you have only one network card in your system. A user wants to host two different initial homepages on the Web server. After verifying that your Web server does support multiple IP addresses, you can bind multiple IP addresses to a single network adapter by defining an alias. For example, if the second IP address is 192.168.1.3, you can use the command:

```
ifconfig tr0 9.3.1.96 netmask 255.255.255.0 alias
```

After this, you can update your Web server configuration such that users using different URLs will see different initial homepages on the Web server.

Note

There will be no ODM record created. You will need to invoke the same command again when you reboot your system. If your installation has a local startup script defined in the /etc/inittab file, this command should be included in that local startup script.

When this alias is no longer required, you can remove it using the command:

```
ifconfig tr0 9.3.1.96 netmask 255.255.255.0 delete
```

Use the `traceroute` command to check whether the alias has been added or deleted successfully as shown in Figure 97.

```
# traceroute -m 3 9.3.1.96
trying to get source for 9.3.1.96
source should be 9.3.1.141
traceroute to 9.3.1.96 (9.3.1.96) from 9.3.1.141 (9.3.1.141), 3 hops max
outgoing MTU = 1492
 1  * * *
 2  * * *
 3  * * *
# ifconfig tr0 9.3.1.96 netmask 255.255.255.0 alias
# traceroute -m 3 9.3.1.96
trying to get source for 9.3.1.96
source should be 9.3.1.141
traceroute to 9.3.1.96 (9.3.1.96) from 9.3.1.141 (9.3.1.141), 3 hops max
outgoing MTU = 1492
 1  sv1050e (9.3.1.96)  12 ms  1 ms  1 ms
# ifconfig tr0 9.3.1.96 netmask 255.255.255.0 delete
# traceroute -m 3 9.3.1.96
trying to get source for 9.3.1.96
source should be 9.3.1.141
traceroute to 9.3.1.96 (9.3.1.96) from 9.3.1.141 (9.3.1.141), 3 hops max
outgoing MTU = 1492
 1  * * *
 2  * * *
 3  * * *
# 
```

Figure 97. Checking whether Alias Has Been Added and Deleted Successfully

10.13 The .netrc File

The $HOME/.netrc file contains information used by the automatic login feature of the `rexec` and `ftp` commands. It is a hidden file in a user's home directory and must be owned either by the user executing the command or by the root user. If the .netrc file contains a login password, the file's permissions must be set to 600 (read and write by owner only).

Note

The .netrc file is not used by any programs when the `securetcpip` command is running on your system.

The `ftp` command interpreter provides facilities to load macros from the $HOME/.netrc file. With the .netrc file, you can simplify repetitive tasks and use the `ftp` command in unattended modes.

Note

The maximum size of the .netrc file is 4096 bytes. If you need to use more than 4096 bytes, you have to split up your file into multiple parts and write a script to automate the FTP job.

10.13.1 The .netrc File Format

The .netrc file can contain the following entries (separated by spaces, tabs, or new lines):

machine *HostName* The HostName variable is the name of a remote host. This entry begins the definition of the automatic login process for the specified host. All following entries up to the next machine entry or the end of the file apply to that host.

login *UserName* The UserName variable is the full domain user name for use at the remote host. If this entry is found, the automatic login process initiates a login using the specified name. If this entry is missing, the automatic login process is unsuccessful.

password *Password* The Password variable is the login password to be used. The automatic login process supplies this password to the remote server. A login password must be established at the remote host, and that password must be entered in the .netrc file. Otherwise, the automatic login process is unsuccessful, and the user is prompted for the login password.

account *Password* The Password variable is the account password to be used. If this entry is found, and an account password is required at the remote host, the automatic login process supplies the password to the remote server. If the remote host requires an account password, but

this entry is missing, the automatic login process prompts for the account password.

macdef *MacroName* The MacroName variable is the name of an FTP subcommand macro. The macro is defined to contain all of the following FTP subcommands up to the next blank line or the end of the file. If the macro is named init, the `ftp` command executes the macro upon successful completion of the automatic login process. The `rexec` command does not recognize a macdef entry.

10.13.2 Sample .netrc File

A sample .netrc file is created by modifying one of the files created by the fixdist package. Only one of the fixes to be downloaded is retained for illustration purposes. In essence, Figure 98 shows the content of a typical .netrc file.

```
$ cat .netrc
machine service.software.ibm.com login anonymous password pw0rd@ macdef init
bin
lcd /ptf/
site exec lfixdist "devices.buc.00004001.rte.4.3.1.1:0:0:202615808:125:IBM:fixdi
stm:0:usrname@hostname"
get /aix/fixes/v4/os/bos.64bit.4.3.1.4.bff bos.64bit.4.3.1.4.bff
get /aix/fixes/v4/os/bos.64bit.4.3.1.4.info bos.64bit.4.3.1.4.info
quit

$ 
```

Figure 98. A Sample .netrc File

If you are using your own user name and password, replace `anonymous` with your own user name and `pw0rd` with your password.

10.13.3 Handling Multiple .netrc Files

You can use a simple script to handle multiple .netrc files to use the `ftp` command in unattended mode. When you are downloading a large number of fixes, do this after office hours in unattended mode. The fixdist package will create multiple .netrc files with suffixes 1, 2, 3, and so on such that each file is smaller than 4096 bytes. The sample script as shown in Figure 99 will copy each .netrc file with suffixes 1, 2, 3, and so on to the $HOME directory and then execute the `ftp` command.

```
#!/usr/bin/ksh
for i in .fixdist_home/.netrc[0-9]*  # .netrc0 1 2...10 11 12...
do
 cp $i .netrc                        # ftp script to be used
 ftp -v service.software.ibm.com >> ./ptfload.log 2>&1
                                     # Download fixes and save output
done
rm .netrc                            # Clean up ftp script
```

Figure 99. A Sample Script to Download Fixes

Note

Additional coding should be added to verify whether the download of individual fixes has been successful and include a housekeeping routine, if needed. But that is outside the scope of FTP and the .netrc file.

Submit the job using the `at` command so that the script will be executed at the time you have planned. For example, if you have a script called `getfixes` and you want to schedule it to run at 11 p.m. on 2 November 1998, you will use:

```
at -f getfixes -t 199811022300
```

10.14 The uname Command

Apart from the `hostname` command, you can also use the `uname -n` command to display the hostname of your system. Without any flags, the `uname` command will display the operating system that your are using.

You can also use the `uname -x` command to display:

- The operating system that your are using
- The hostname
- The machine ID number of the hardware running the system
- The release number of the operating system
- The operating system version
- The system model name

A few examples of the use of the `uname` command is shown in Figure 100 on page 257.

```
$ uname
AIX
$ uname -n
rs1800a
$ uname -x
AIX rs1800a 1632719180 3 4 006151514C00
$
```

Figure 100. The uname Command

10.15 Basic Network Problem Determination

When a user informs you that a certain system cannot be accessed, check for various network problems. Typically, you will go through these TCP/IP problem determination topics using whichever is applicable to your environment:

- Communication Problems
- Name Resolution Problems
- Routing Problems
- Problems with System Resource Controller (SRC) Support
- Telnet or rlogin Problems
- Configuration Problems
- Common Problems with Network Interfaces
- Problems with Packet Delivery
- Problems with Dynamic Host Configuration Protocol (DHCP)

However, there are other consideration outside the network area that you should check also:

- The server system may be down.

  This will usually reveal itself when you check for communication problems. The `ping` command will lead you to the problem system. The whole system may be down or the network interface may be down.

- The paging space may be full.

  If a user has logged in, this will be fairly obvious as there is usually a system message stating not enough paging space or not enough memory. However, if a user is trying to `telnet` or `ftp` to the system, there will be time outs as the system cannot create additional processes, or the system may be busy killing processes.

- A file system may be full.

  If the user can access the system, but there are problems with certain functions, you should check all areas in the system. If the user cannot start the Web Based System Manager (WSM), the /tmp filesystem may be full.

- A file system may not have been mounted.

  Usually, the user will mention losing all his files.

Not all problems are caused by the network and the network function. Make sure you understand your user's problem before concluding that it is a network problem.

10.16 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. Which of the following actions will allow the system administrator to stop and restart the TCP/IP daemons manually?

   A. Use the `netstat` command.

   B. Use the SRC utility to stop and restart.

   C. Use the netconfig utility menu.

   D. Issue the `rmdev` command on the appropriate network adapter.

2. Two Web servers need to be configured on a single machine that has only one network interface. Each Web server needs to have its own unique IP address. How should an administrator accomplish this?

   A. Use the `smitty alias` command

   B. Add it in /etc/defaults

   C. Use the `newaliases 192.127.10.10` command

   D Use the `ifconfig en0 alias 192.127.10.10` command

10.16.1 Answers

The following are the answers to the previous questions:

1. B
2. D

10.17 Exercises

Provided here are some exercises you may wish to perform:

1. After installing a new network adapter or after replacing a Token Ring adapter with an Ethernet adapter, what are the steps to restart TCP/IP?
2. Configure an network interface using SMIT.
3. Start and stop TCP/IP daemons using /etc/rc.tcpip and /etc/tcp.clean.
4. Name the SMIT fastpaths needed for networking, such as tcpip, route, and others.
5. Change the IP address using SMIT.
6. Describe the inetd, portmap, and other TCP/IP daemons. What errors will users experience when any one of the TCP/IP daemons is not started?
7. What are the errors if the /etc/resolv file is incorrect?
8. How do you add a route?
9. Create and delete an IP alias using the `ifconfig` command.
10. Does ping work without starting TCP/IP?
11. Use the $HOME/.netrc file to eliminate the user login and password prompts for the `rexec` and `ftp` commands.

Chapter 11. Network File System Administration

The Network File System (NFS) is a distributed file system that allows users to access files and directories as if they were local. For example, the user can use operating systems commands to create, remove, read, write, and set file attributes for remote files and directories. NFS is independent of machine types, operating systems, and network architectures through the use of remote procedure calls (RPC). This section discusses the tasks that can be performed by an administrator in an NFS environment.

11.1 NFS Services

NFS provides its services through a client-server relationship. The computers that make their file systems, directories, and other resources available for remote access are called *servers.* The act of making file systems available is called exporting. The computers, or the processes they run, that use a server's resources are considered clients. Once a client mounts a file system that a server exports, the client can access the individual server files (access to exported directories can be restricted to specific clients).

The following are a list of terms that are used throughout this discussion:

Server A computer that makes its file systems, directories, and other resources available for remote access.

Clients The computers, or processes that use a server's resources.

Export The act of making file systems available to remote clients.

Mount The act of a client accessing the file systems a server exports.

The major services provided by NFS are:

Mount From the /usr/sbin/rpc.mountd daemon on the server and the `/usr/sbin/mount` command on the client. The mountd daemon is a Remote Procedure Call (RPC) that answers a client request to mount a file system. The mountd daemon finds out which file systems are available by reading the /etc/xtab file. In addition, the mountd daemon provides a list of currently mounted file systems and the clients on which they are mounted.

Remote File Access From the /usr/sbin/nfsd daemon on the server and the /usr/sbin/biod daemon on the client.

	Handles client requests for files. The biod daemon runs on all NFS client systems. When a user on a client wants to read or write to a file on a server, the biod daemon sends this request to the server.
Remote Execution	From the /usr/sbin/rpc.rexd daemon on the server and the `/usr/bin/on` command on the client.The rexd daemon executes programs for remote machines when a client issues a request to execute a program on a remote machine.
Remote System Statistics	From the /usr/sbin/rpc.rstatd daemon on the server and the `/usr/bin/rup` command on the client. The rstatd daemon is a server that returns performance statistics obtained from the kernel.
Remote User Listing	From the /usr/lib/netsvc/rusers/rpc.rusersd daemon on the server and the `/usr/bin/rusers` command on the client. The rusersd daemon is a server that responds to queries from the `rusers` command by returning a list of users currently on the network.
Boot Parameters	Provides boot parameters to SunOS diskless clients from the /usr/sbin/rpc.bootparamd daemon on the server.
Remote Wall	From the /usr/lib/netsvc/rwall/rpc.rwalld daemon on the server and the `/usr/sbin/rwall` command on the client. The rwalld daemon handles requests from the `rwall` command. The `rwall` command sends messages to all users on the network.
Spray	Sends a one-way stream of Remote Procedure Call (RPC) packets from the /usr/lib/netsvc/spray/rpc.sprayd daemon on the server and the `/usr/sbin/spray` command on the client.
PC Authentication	Provides a user authentication service for PC-NFS from the /usr/sbin/rpc.pcnfsd daemon on the server.

An NFS server is *stateless*. That is, an NFS server does not have to remember any transaction information about its clients. In other words, NFS

transactions are atomic: A single NFS transaction corresponds to a single, complete file operation. NFS requires the client to remember any information needed for later NFS use.

Figure 101 is an illustration of the NFS configuration discussed in this section.

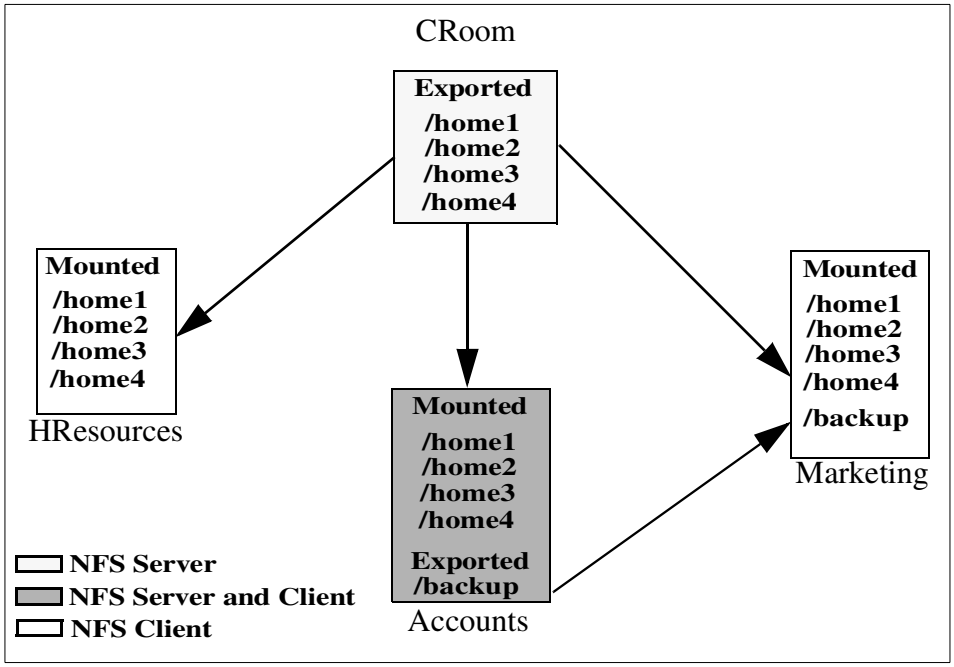

Figure 101. A Typical NFS Environment

The environment illustrated in Figure 101 includes two NFS servers and three clients where one system is both a server and a client. The CRoom server exports its directories allowing all other systems to have access to them. The Accounts server shares one directory that only Marketing has access to. The following section recreates the scenario illustrated and discusses any challenges and tasks that arise while administrating NFS in this environment.

11.2 Planning, Installation, and Configuration of NFS

There are no specific installation tasks needed for NFS as the Base Operating System (BOS) Installation also includes the default installation of network services, such as TCPIP and NFS.

Before starting the configuration of NFS on any of the systems, perform the following tasks:

1. Identify which systems in the network will be servers and which will be clients (a system can be configured as both a server and a client). As shown in Figure 101, CRoom and Accounts are servers, and HResources and Marketing are clients. Note that Accounts is both a client and server.
2. Start the NFS daemons for each system (whether client or server). The NFS daemons, by default, are not started on a newly installed system. When a system is first installed, all of the files are placed on the system, but the steps to activate NFS are not taken. The daemons can be started by:
   - Using the SMIT fast path:

     ```
     smitty mknfs
     ```

   - Using the `mknfs` command to start the NFS daemons immediately, and this should produce the following:

```
# mknfs -N
0513-059 The portmap Subsystem has been started. Subsystem PID is 23734.
Starting NFS services:
0513-059 The biod Subsystem has been started. Subsystem PID is 27264.
0513-059 The nfsd Subsystem has been started. Subsystem PID is 30570.
0513-059 The rpc.mountd Subsystem has been started. Subsystem PID is 28350.
0513-059 The rpc.statd Subsystem has been started. Subsystem PID is 15298.
0513-059 The rpc.lockd Subsystem has been started. Subsystem PID is 30976.
#
```

Table 34 lists the most common flags of the `mknfs` command.

Table 34. Flags for the mknfs Command

Flag	Description
-B	Adds an entry to the inittab file to execute the /etc/rc.nfs file on system restart. The `mknfs` command also executes the /etc/rc.nfs file immediately to start the NFS daemons. This flag is the default.
-I	Adds an entry to the inittab file to execute the /etc/rc.nfs file on system restart.
-N	Starts the /etc/rc.nfs file to start the NFS daemons immediately. When started this way, the daemons run until the next system restart.

The -B and -I options place an entry in the inittab file so that the /etc/rc.nfs script is run each time the system restarts. This script, in turn, starts all NFS daemons required for a particular system.

For each system that is to be a server (CRoom and Accounts), use the following instructions to configure them as NFS Server:

1. Start the NFS daemons using SRC if not already started.

   The NFS daemons can be started individually or all at once. To start NFS daemons individually:

   ```
   startsrc -s daemon
   ```

   where daemon is any one of the SRC controlled daemons (See 11.4, “NFS Files, Commands, and Daemons Reference” on page 279). For example, to start the nfsd daemon:

   ```
   startsrc -s nfsd
   ```

   To start all of the NFS daemons:

   ```
   startsrc -g nfs
   ```

   Note

   If the /etc/exports file does not exist, the nfsd and the rpc.mountd daemons will not be started. You can create an empty /etc/exports file by running the command `touch /etc/exports`. This will allow the nfsd and the rpc.mountd daemons to start although no file systems will be exported.

2. Create the exports in the /etc/exports file.

11.2.1 Exporting NFS

This section discusses the use of the `exportfs` command.

11.2.1.1 Export an NFS Using SMIT

In order to export file systems using SMIT, follow this procedure:

1. Verify that NFS is already running on CRoom and Accounts servers by entering the command `lssrc -g nfs`. As in the following example, the output should indicate that the nfsd and the rpc.mountd daemons are active. If they are not, start NFS using the instructions in 11.2, “Planning, Installation, and Configuration of NFS” on page 263.

   ```
   # lssrc -g nfs
   Subsystem         Group            PID     Status
    biod             nfs              15740   active
    nfsd             nfs              11376   active
    rpc.mountd       nfs              5614    active
    rpc.statd        nfs              16772   active
    rpc.lockd        nfs              15496   active
   #
   ```

2. Use `smitty mknfsexp` to export the directory; the SMIT screen is as shown in Figure 102.

```
                        Add a Directory to Exports List

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

                                                      [Entry Fields]
* PATHNAME of directory to export                    [/home1]                  /
* MODE to export directory                            read-write               +
  HOSTS & NETGROUPS allowed client access            []
  Anonymous UID                                      [-2]
  HOSTS allowed root access                          []
  HOSTNAME list. If exported read-mostly             []
  Use SECURE option?                                  no                       +
  Public filesystem?                                  no                       +
* EXPORT directory now, system restart or both        both                     +
  PATHNAME of alternate Exports file                 []

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

Figure 102. Adding a Directory to Export List

3. For CRoom Server, specify /home1, and on Accounts /backup in the PATHNAME of directory to export field, set read-write MODE to export directory, and set both for EXPORT directory now, system restart, or both fields.
4. Specify any other optional characteristics you want or accept the default values by leaving the remaining fields as they are. For this illustration, for Accounts, set the Hosts and NetGroups allowed client access field to Marketing and keep the default for everything else.
5. When you have finished making your changes, SMIT updates the /etc/exports file. If the /etc/exports file does not exist, then it will be created.
6. Repeat steps 3 through 5 for directories /home2, /home3, /home4 on CRoom. Accounts is only exporting /backup; so, there is no need to do any other exports.
7. If NFS is currently running on the servers, enter:

   ```
   /usr/sbin/exportfs -a
   ```

   The -a option tells the `exportfs` command to send all information in the /etc/exports file to the kernel. If NFS is not running, start NFS using the

instructions in 11.2, “Planning, Installation, and Configuration of NFS” on page 263.

8. Verify that all file systems have been exported properly as follows:

   For the CRoom Server:

```
# showmount -e CRoom
export list for CRoom:
/home1     (everyone)
/home2     (everyone)
/home3     (everyone)
/home4     (everyone)
#
```

   For the Accounts Server:

```
# showmount -e Accounts
export list for Accounts:
/backup Marketing
#
```

11.2.1.2 To Export an NFS Using a Text Editor

In order to export file systems using a text editor, follow this procedure:

1. Open the /etc/exports file with your favorite text editor.

```
vi /etc/exports
```

2. Create an entry for each directory to be exported using the full path name of the directory as shown in Figure 103 on page 268.

.

```
/home1
/home2
/home3
/home4
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
"/etc/exports" 4 lines, 28 characters
```

Figure 103. Content of /etc/exports for CRoom Server

3. List each directory to be exported starting in the left margin. No directory should include any other directory that is already exported. Save and close the /etc/exports file.

11.2.1.3 Export an NFS Temporarily

A file system can be exported when needed, and as such, does not change the /etc/exports file. This is done by entering:

```
exportfs -i /dirname
```

where `dirname` is the name of the file system you want to export. The `exportfs -i` command specifies that the /etc/exports file is not to be checked for the specified directory, and all options are taken directly from the command line.

For each system that is to be a client (HResources, Accounts, and Marketing), the following steps will ensure that they have access to directories and files on the CRoom and Accounts Servers.

1. Verify that NFS is the default remote file system. If this is not done, you will need to specify the -v nfs flag when using the `mount` command. Using a text editor, open the /etc/vfs file and search for the following entries:

   ```
   %defaultvfs jfs nfs
   nfs 2 /sbin/helpers/nfsmnthelp none remote
   ```

If pound signs (#) appear at the beginning of the lines as shown, delete the pound signs.

2. Save and close the /etc/vfs file.
3. Start NFS using the instructions in 11.2, “Planning, Installation, and Configuration of NFS” on page 263.
4. Go to 11.2.3, “Mounting an NFS” on page 269.

11.2.2 Unexporting an NFS

You can unexport an NFS directory using one of the following procedures.

- To unexport an NFS directory using SMIT:
  1. On the CRoom Server, enter the following command to remove /home4 export:

     ```
     smitty rmnfsexp
     ```

  2. Enter /home4 in the PATHNAME of the exported directory to be removed from the field.

  The directory is now removed from the /etc/exports file and is unexported.
- To Unexport an NFS by using a text editor:
  1. Open the /etc/exports file with a text editor.
  2. Find the entry for the directory you wish to unexport, that is, /home4, and then delete that line.
  3. Save and close the /etc/exports file.
  4. If NFS is currently running, enter:

     ```
     exportfs -u dirname
     ```

     where `dirname` is the full path name of the directory(/home4) you just deleted from the /etc/exports file.

11.2.3 Mounting an NFS

There are three types of NFS mounts: Predefined, explicit, and automatic.

Predefined mounts are specified in the /etc/filesystems file. Each stanza (or entry) in this file defines the characteristics of a mount as shown in Figure 104 on page 270. Data, such as the host name, remote path, local path, and any mount options, are listed in this stanza. Predefined mounts should be used when certain mounts are always required for proper operation of a client.

```
/home1:
dev       = /dev/hd1
vol       = "/home1"
mount     = true
check     = true
free      = false
vfs       = jfs
log       = /dev/hd8
```

Figure 104. Example of a Stanza in the /etc/filesystems File

Explicit mounts serve the needs of the root user. Explicit mounts are usually done for short periods of time when there is a requirement for occasional unplanned mounts. Explicit mounts can also be used if a mount is required for special tasks, and that mount should not be generally available on the NFS client. These mounts are usually fully qualified on the command line by using the `mount` command with all needed information.

Explicit mounts do not require updating the /etc/filesystems file. File systems mounted explicitly remain mounted unless explicitly unmounted with the `umount` command or until the system is restarted.

Automatic mounts are controlled by the `automount` command, which causes the AutoFS kernel extension to monitor specified directories for activity. If a program or user attempts to access a directory that is not currently mounted, then AutoFS intercepts the request, arranges for the mount of the file system, and then services the request.

11.2.3.1 NFS Mounting Process

Clients access files on the server by first mounting a server's exported directories. When a client mounts a directory, it does not make a copy of that directory. Rather, the mounting process uses a series of remote procedure calls to enable a client to access the directories on the server transparently. The following describes the mounting process:

1. When the server starts, the /etc/rc.nfs script runs the `exportfs` command, which reads the server /etc/exports file and then tells the kernel which directories are to be exported and which access restrictions they require.
2. The rpc.mountd daemon and several nfsd daemons (eight, by default) are then started by the /etc/rc.nfs script.
3. When the client starts, the /etc/rc.nfs script starts several biod daemons (eight, by default), which forward client mount requests to the appropriate server.

4. Then the /etc/rc.nfs script executes the `mount` command, which reads the file systems listed in the /etc/filesystems file.
5. The `mount` command locates one or more servers that export the information the client wants and sets up communication between itself and that server. This process is called *binding*.
6. The `mount` command then requests that one or more servers allow the client to access the directories in the client /etc/filesystems file.
7. The server rpc.mountd daemon receives the client mount requests and either grants or denies them. If the requested directory is available to that client, the rpc.mountd daemon sends the client's kernel an identifier called a *file handle*.
8. The client kernel then ties the file handle to the mount point (a directory) by recording certain information in a mount record.

Once the file system is mounted, the client can perform file operations. When the client does a file operation, the biod daemon sends the file handle to the server, where the file is read by one of the nfsd daemons to process the file request. Assuming the client has access to perform the requested file operation, the nfsd daemon returns the necessary information to the client's biod daemon.

The following procedure helps to complete the scenario shown in Figure 101 on page 263.

1. On HResources, establish the local mount point for /home1 on server CRoom using the `mkdir` command.

   ```
   mkdir /home1
   ```

   This directory should be empty. This mount point can be created like any other directory, and no special attributes are needed for this directory.

   Note

   The mount points for all NFS mounts must exist on your system before you can mount a file system with one exception. If the automount daemon is used, it may not be necessary to create mount points. See 11.2.3.4, “Mounting an NFS Automatically” on page 275.

2. On HResources, establish and mount the predefined mounts by following the instructions in 11.2.3.2, “Establishing Predefined NFS Mounts” on page 272.

11.2.3.2 Establishing Predefined NFS Mounts

You can establish predefined NFS mounts using one of the following procedures.

> **Note**
>
> Define the bg (background) and intr (interruptible) options in the /etc/filesystems file when establishing a predefined mount that is to be mounted during system startup. Mounts that are non-interruptible and running in the foreground can hang the client if the network or server is down when the client system starts up. If a client cannot access the network or server, the user must start the machine again in maintenance mode and edit the appropriate mount requests.

To establish predefined mounts through SMIT (Figure 105), use the following command:

```
smitty mknfsmnt
```

```
                        Add a File System for Mounting

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

[TOP]                                                   [Entry Fields]
* PATHNAME of mount point                              []                          /
* PATHNAME of remote directory                         []
* HOST where remote directory resides                  []
  Mount type NAME                                      []
* Use SECURE mount option?                             no                        +
* MOUNT now, add entry to /etc/filesystems or both?    now                       +
* /etc/filesystems entry will mount the directory      no                        +
   on system RESTART.
* MODE for this NFS file system                        read-write                +
* ATTEMPT mount in foreground or background            background                +
  NUMBER of times to attempt mount                     []                         #
  Buffer SIZE for read                                 []                         #
  Buffer SIZE for writes                               []                         #
[MORE...26]

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

Figure 105. Adding a File System for Mounting

Specify values in this screen for each mount you want predefined. You must specify a value for each required field (those marked with an asterisk (*) in the left margin). You may specify values for the other fields or accept their default values. This method creates an entry in the /etc/filesystems file for the desired mount and attempts the mount.

To establish the NFS default mounts by editing the /etc/filesystems file (only use this method under special circumstances), perform the following:

1. Open the /etc/filesystems file on HResources with a text editor. Add entries for each of the remote file systems that you want mounted when the system is started. For example:

   ```
   /home1:
   dev = /home1
   mount = false
   vfs = nfs
   nodename = CRoom
   options = ro,soft
   type = nfs_mount
   ```

   This stanza directs the system to mount the /home1 remote directory over the local mount point of the same name. The file system is mounted as read-only (ro). Because it is also mounted as soft, an error is returned in the event the server does not respond. By specifying the type parameter as nfs_mount, the system attempts to mount the /home1 file system (along with any other file systems that are specified in the type = nfs_mount group) when the `mount -t nfs_mount` command is issued.

   The following example stanza directs the system to mount the /home2 file system at system startup time. If the mount fails, the system continues to attempt to mount in the background.

   ```
   /home2:
   dev = /home2
   mount = true
   vfs = nfs
   nodename = CRoom
   options = ro,soft,bg
   type = nfs_mount
   ```

   Note

   See 11.2.3.5, “Parameters” on page 276 for additional parameters.

2. Remove any directory entries that you do not want to mount automatically at system startup.
3. Save and close the file.
4. Run the `mount -a` command to mount all the directories specified in the /etc/filesystems file.
5. On Marketing, repeat mount for /backup directory from Accounts

The NFS is now ready to use.

11.2.3.3 Mounting an NFS Explicitly

To mount an NFS directory explicitly, use the following procedure:

1. Verify that the NFS server has exported the directory, using:

   ```
   showmount -e ServerName
   ```

   For Server CRoom:

   ```
   # showmount -e CRoom
   export list for CRoom:
   /home1     (everyone)
   /home2     (everyone)
   /home3     (everyone)
   /home4     (everyone)
   #
   ```

   where `ServerName` is the name of the NFS server. This command displays the names of the directories currently exported from the NFS server. If the directory you want to mount is not listed, export the directory from the server.

2. Establish the local mount point using the `mkdir` command. For NFS to complete a mount successfully, a directory that acts as the mount point (or place holder) of an NFS mount must be present. This directory should be empty. This mount point can be created like any other directory, and no special attributes are needed for this directory.

3. On the HResources machine, enter the following SMIT fast path:

   ```
   smitty mknfsmnt
   ```

4. Make changes to the following fields that are appropriate for your network configuration. Your configuration may not require completing all of the entries on this screen.

   - PATHNAME of mount point.
   - PATHNAME of remote directory.
   - HOST where remote directory resides.
   - MOUNT now, add entry to /etc/filesystems or both?
   - /etc/filesystems entry will mount the directory on system RESTART.
   - MODE for this NFS.

> **Note**
>
> If you are using the ASCII SMIT interface, press the **Tab** key to change to the correct value for each field, but do not press **Enter** until you get to step 7.

5. Use the default values for the remaining entries or change them depending on your NFS configuration.
6. When you finish making all the changes on this screen, SMIT mounts the NFS.
7. When the Command: field shows the OK status, exit SMIT.

The NFS is now ready to use.

11.2.3.4 Mounting an NFS Automatically

AutoFS relies on the use of the `automount` command to propagate the automatic mount configuration information to the AutoFS kernel extension and start the automountd daemon. Through this configuration propagation, the extension automatically and transparently mounts file systems whenever a file or a directory within that file system is opened. The extension informs the automountd daemon of mount and unmount requests, and the automountd daemon actually performs the requested service.

Because the name-to-location binding is dynamic within the automountd daemon, updates to a Network Information Service (NIS) map used by the automountd daemon are transparent to the user. Also, there is no need to pre-mount shared file systems for applications that have hard-coded references to files and directories, nor is there a need to maintain records of which hosts must be mounted for particular applications.

AutoFS allows file systems to be mounted as needed. With this method of mounting directories, all file systems do not need to be mounted all of the time, only those being used are mounted.

For example, to mount the /backup NFS directory automatically:

1. Verify that the NFS server has exported the directory by entering:

   ```
   # showmount -e Accounts
   export list for Accounts:
   /backup Marketing
   #
   ```

   This command displays the names of the directories currently exported from the NFS server.
2. Create an AutoFS map file. AutoFS will mount and unmount the directories specified in this map file. For example, suppose you want to use AutoFS to mount the /backup directory as needed from the Accounts server onto the remote /backup directory. In this example, the map file name is /tmp/mount.map. An example of a map file can be found in /usr/samples/nfs.

3. Ensure that the AutoFS kernel extension is loaded and the automountd daemon is running. This can be accomplished in two ways:

   a. Using SRC, enter:

      ```
      lssrc -s automountd
      ```

      If the automountd subsystem is not running, issue: `startsrc -s automountd`

   b. Using the `automount` command, issue `/usr/sbin/automount -v`. Define the map file using the command line interface by entering:

      ```
      /usr/sbin/automount -v /backup /tmp/mount.map
      ```

      where `/backup` is the AutoFS mount point on the client. Now, if a user runs the `cd /backup` command, the AutoFS kernel extension will intercept access to the directory and will issue a remote procedure call to the automountd daemon, which will mount the /backup directory and then allow the `cd` command to complete.

4. To stop the automountd, issue the `stopsrc -s automountd` command.

   If, for some reason, the automountd daemon was started without the use of SRC, issue:

   ```
   kill automountd_PID
   ```

   where `automountd_PID` is the process ID of the automountd daemon. (Running the `ps -e` command will display the process ID of the automountd daemon.) The `kill` command sends a SIGTERM signal to the automountd daemon.

11.2.3.5 Parameters

The parameters required for stanzas pertaining to NFS mounts are:

dev=filesystem_name Specifies the path name of the remote file system being mounted.

mount=[true|false] If true, specifies that the NFS will be mounted when the system boots. If false, the NFS will not be mounted when the system boots.

nodename=hostname Specifies the host machine on which the remote file system resides.

vfs=nfs Specifies that the virtual file system being mounted is an NFS.

If you do not set the following options, the kernel automatically sets them to the following default values:

- biods=6
- fg
- retry=10000
- rsize=8192
- wsize=8192
- timeo=7
- retrans=3
- port=NFS_PORT
- hard
- secure=off
- acregmin=3
- acregmax=60
- acdirmin=30
- acdirmax=60

11.3 Administration of NFS Servers and Clients

In this section, the operations a system administrator will be performing when working with NFS are discussed. The topics being discussed are:

- The status of the NFS daemons
- Changing exported NFSs
- Using the `unmount` command

11.3.1 Get the Current Status of the NFS Daemons

You can get the current status of the NFS daemons individually or all at once. To get the current status of the NFS daemons individually, enter:

```
lssrc -s subsystem
```

where `daemon` is any one of the SRC controlled daemons. For example, to get the current status of the `rpc.lockd` daemon, enter:

```
lssrc -s rpc.lockd
```

To get the current status of all daemons at once, enter:

```
lssrc -a
```

11.3.2 Changing an Exported File System

This section explains how you can change an exported NFS.

11.3.2.1 Change an Exported NFS using SMIT

The following procedure will guide you through exporting a file system using SMIT.

1. Unexport the file system by entering:

   ```
   exportfs -u /dirname
   ```

   where `dirname` is the name of the file system you want to change. In this case, /home3.

2. On the CRoom server, enter:

   ```
   smitty chnfsexp
   ```

   The resulting screen is shown in Figure 106.

3. Enter the appropriate path name in the PATHNAME of exported directory field. In this case, /home3.

```
                  Change Attributes of an Exported Directory

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

                                                      [Entry Fields]
* PATHNAME of Directory to Export                     /home3
* MODE to export directory                            read-write              +
  HOSTS & NETGROUPS allowed client access             []
  Anonymous UID                                       [-2]
  HOSTS allowed root access                           []
  HOSTNAME list. If exported read-mostly              []
  Use SECURE OPTION?                                   no                     +
  Public filesystem?                                   no                     +
* CHANGE export now, system restart or both            both                   +
  PATHNAME of alternate Exports file                  []

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

Figure 106. Change the Attributes of an Exported Directory

   Make whatever changes you need.

4. Exit SMIT.

5. Re-export the file system by entering:

```
exportfs /dirname
```

where `dirname` is the name of the file system you just changed, in this case /home3.

11.3.2.2 Change an Exported NFS Using a Text Editor

The following procedure will guide you through changing an exported file system using a text editor.

1. Unexport the file system by entering:

   ```
   exportfs -u /dirname
   ```

   where `dirname` is the name of the file system you want to change, in this case /home3.
2. Open the /etc/exports file with your favorite text editor.
3. Make whatever changes you want.
4. Save and close the /etc/exports file.
5. Re-export the file system by entering:

   ```
   exportfs /dirname
   ```

   where `dirname` is the name of the file system you just changed in this case /home3.

11.3.3 Unmounting a Mounted File System

To unmount an explicitly or automatically mounted NFS directory, enter `umount /directory` or `unmount /directory`, for example:

```
umount /backup
```

The `rmfs` command can be used to remove any file systems you created.

11.4 NFS Files, Commands, and Daemons Reference

In this section, the key NFS files, commands, and daemons are defined.

11.4.1 List of NFS Files

The following is a list of key NFS files.

/etc/bootparams	Lists servers that diskless clients can use for booting.
/etc/exports	Lists the directories that can be exported to NFS clients.

/etc/networks	Contains information about networks on the Internet network.
/etc/pcnfsd.conf Configuration File	Options for the rpc.pcnfsd daemon.
/etc/rpc	Contains database information for Remote Procedure Call (RPC) programs.
/etc/xtab	Lists directories that are currently exported.
/etc/filesystems	Lists all file systems that can potentially be mounted and their mounting configuration.

11.4.1.1 List of NFS Commands

The following is a list of NFS Commands.

`chnfs`	Starts a specified number of biod and nfsd daemons.
`mknfs`	Configures the system to run NFS and starts NFS daemons.
`nfso`	Configures NFS network options.
`automount`	Mounts an NFS automatically.
`chnfsexp`	Changes the attributes of an NFS-exported directory.
`chnfsmnt`	Changes the attributes of an NFS-mounted directory.
`exportfs`	Exports and unexports directories to NFS clients.
`lsnfsexp`	Displays the characteristics of directories that are exported with NFS.
`lsnfsmnt`	Displays the characteristics of mounted NFS systems.
`mknfsexp`	Exports a directory using NFS.
`mknfsmnt`	Mounts a directory using NFS.
`rmnfs`	Changes the configuration to stop the NFS daemons.
`rmnfsexp`	Removes NFS-exported directories from a server's list of exports.
`rmnfsmnt`	Removes NFS-mounted file systems from a client's list of mounts.

11.4.1.2 List of NFS daemons

The following is a list of NFS Locking daemons.

/usr/sbin/rpc.lockd Processes lock requests through the RPC package.

/usr/sbin/rpc.statd Provides crash-and-recovery functions for the locking services on NFS.

The following is a list of NFS Network Service daemons and utilities.

/usr/sbin/biod	Sends the client's read and write requests to the server. The biod daemon is SRC controlled.
/usr/sbin/rpc.mountd	Answers requests from clients for file system mounts. The mountd daemon is SRC controlled.
/usr/sbin/nfsd	Starts the daemons that handle a client's request for file system operations. nfsd is SRC controlled.
/usr/sbin/nfsstat	Displays information about a machine's ability to receive calls.
/usr/bin/on	Executes commands on remote machines.
/usr/sbin/portmap	Maps RPC program numbers to Internet port numbers. portmap is inetd Controlled.
/usr/sbin/rpc.rexd	Accepts request to run programs from remote machines.
/usr/bin/rpcgen	Generates C code to implement an RPC protocol.
/usr/bin/rpcinfo	Reports the status of RPC servers.
/usr/sbin/rpc.rstatd	Returns performance statistics obtained from the kernel.
/usr/bin/rup	Shows the status of a remote host on the local network.
/usr/bin/rusers	Reports a list of users logged on to the remote machines.
/usr/lib/netsvc/rusers/rpc.rusersd	Responds to queries from the `rusers` command.
/usr/sbin/rwall	Sends messages to all users on the network on the remote network.
/usr/lib/netsvc/rwall/rpc.rwalld	Handles requests from the `rwall` command.

/usr/bin/showmount	Displays a list of all clients that have mounted remote file systems.
/usr/sbin/spray	Sends a specified number of packets to a host.
/usr/sbin/rpc.pcnfsd	Handles service requests from PC-NFS clients.
/usr/lib/netsvc/spray/rpc.sprayd	Receives packets sent by the `spray` command.

11.5 NFS Problem Determination

Troubleshooting NFS problems involves a strategy for tracking NFS problems, recognizing NFS-related error messages, and selecting the appropriate solutions. When tracking down an NFS problem, isolate each of the three main points of failure to determine which is not working: The server, the client, or the network itself.

11.5.1 Identifying NFS Problems Checklist

If a client is having NFS trouble, perform the following tasks:

1. Verify that the network connections are functioning properly.
2. Verify that the inetd, portmap, and biod daemons are running on the client (see 11.3.1, “Get the Current Status of the NFS Daemons” on page 277).
3. Verify that a valid mount point exists on the client system for the file system to be mounted. For more information, see 11.2.3.2, “Establishing Predefined NFS Mounts” on page 272.
4. Verify that the server is up and running by executing the following command at the shell prompt of the client machine:

   ```
   /usr/bin/rpcinfo -p server_name
   ```

   where `server_name` is the name of the server being verified.

   If the server is up, a list of programs, versions, protocols, and port numbers is printed similar to the following:

   ```
   program  vers proto   port
   100000    2   tcp    111  portmapper
   100000    2   udp    111  portmapper
   100005    1   udp   1025  mountd
   100001    1   udp   1030  rstatd
   100001    2   udp   1030  rstatd
   100001    3   udp   1030  rstatd
   ```

```
100002    1   udp   1036  rusersd
100002    2   udp   1036  rusersd
100008    1   udp   1040  walld
100012    1   udp   1043  sprayd
100005    1   tcp    694  mountd
100003    2   udp   2049  nfs
100024    1   udp    713  status
100024    1   tcp    715  status
100021    1   tcp    716  nlockmgr
100021    1   udp    718  nlockmgr
100021    3   tcp    721  nlockmgr
100021    3   udp    723  nlockmgr
100020    1   udp    726  llockmgr
100020    1   tcp    728  llockmgr
100021    2   tcp    731  nlockmgr
```

If a similar response is not returned, log in to the server at the server console and check the status of the inetd daemon by following the instructions in 11.3.1, “Get the Current Status of the NFS Daemons” on page 277.

5. Verify that the mountd, portmap, and nfsd daemons are running on the NFS server by entering the following commands at the client shell prompt:

   - `/usr/bin/rpcinfo -u server_name mount.`
     As shown in the following example:

     ```
     # /usr/bin/rpcinfo -u CRoom mount
     program 100005 version 1 ready and waiting
     program 100005 version 2 ready and waiting
     program 100005 version 3 ready and waiting
     #
     ```

   - `/usr/bin/rpcinfo -u server_name portmap.`
     As shown in the following example:

     ```
     # /usr/bin/rpcinfo -u CRoom portmap
     program 100000 version 2 ready and waiting
     program 100000 version 3 ready and waiting
     program 100000 version 4 ready and waiting
     #
     ```

   - `/usr/bin/rpcinfo -u server_name nfs.`
     As shown in the following example:

     ```
     # /usr/bin/rpcinfo -u CRoom nfs
     program 100003 version 2 ready and waiting
     program 100003 version 3 ready and waiting
     #
     ```

The program numbers correspond to the commands, respectively, as shown in the preceding example. If a similar response is not returned, log in to the server at the server console and check the status of the daemons by following the instructions in 11.3.1, “Get the Current Status of the NFS Daemons” on page 277.

6. Verify that the /etc/exports file on the server lists the name of the file system that the client wants to mount and that the file system is exported. Do this by entering the command:

   ```
   showmount -e server_name
   ```

   This command will list all the file systems currently exported by the `server_name`.

11.5.2 Checking Network Connections

If the biod daemons are working, check the network connections. The `nfsstat` command determines whether you are dropping packets. Use the `nfsstat -c` and `nfsstat -s` commands to determine if the client or server is retransmitting large blocks. Retransmissions are always a possibility due to lost packets or busy servers. A retransmission rate of 5 percent is considered high.

The probability of retransmissions can be reduced by changing the communication adapter transmit queue parameters, no settings, to name two. SMIT or the `no` command can be used to change these parameters.

11.5.3 NFS Error Messages

The following sections explain error codes that can be generated while using NFS.

11.5.3.1 Hard-Mounted and Soft-Mounted File Problems

When the network or server has problems, programs that access hard-mounted remote files fail differently from those that access soft-mounted remote files.

If a server fails to respond to a hard-mount request, NFS prints the message:

```
NFS server hostname not responding, still trying
```

If a server fails to respond to a soft-mount request, NFS prints the message:

```
Connection timed out
```

11.5.3.2 Bad Sendreply Error Message

Insufficient transmit buffers on your network can cause the following error message:

```
nfs_server: bad sendreply
```

To increase transmit buffers, use the System Management Interface Tool (SMIT) fast path `smitty commodev`. Then select your adapter type and increase the number of transmit buffers.

11.5.3.3 Server Not Responding

Use the procedure in 11.5.1, “Identifying NFS Problems Checklist” on page 282 to troubleshoot this error. The error usually occurs if the NFS daemons have not been started or have been stopped. If the mountd or the nfsd daemons were not started or were stopped on the server, then when a client tries to mount an exported file system, an 1831-010 error message is displayed.

For example, if the rpc.mountd daemon dies after starting, and this error is received at a client machine, then do the following:

1. Telnet to the server and log in as root.
2. `cd` to the /etc directory
3. Enter `stopsrc -g nfs`.
4. Enter `stopsrc -s portmap`.
5. Enter `rm -rf state sm sm.bak xtab rmtab`.
6. Enter `startsrc -s portmap`.
7. Enter `startsrc -g nfs`.
8. Enter `exportfs -a`.
9. `showmount -e servername`.

The `rm -rf` command clears the mountd files that may be too large for mountd to handle. If this procedure does not work, then refer to section 11.5, “NFS Problem Determination” on page 282.

11.5.3.4 Remote Mounting Errors

The following list provides common mounting errors and their probable causes.

1. A remote mounting process can fail in several ways. The error messages associated with mounting failures are as follows:

   ```
   mount: ... already mounted
   ```

   The file system that you are trying to mount is already mounted.

   ```
   mount: ... not found in /etc/filesystems
   ```

The specified file system or directory name cannot be matched.

2. If you issue the `mount` command with either a directory or file system name but not both. The command looks in the /etc/filesystems file for an entry whose file system or directory field matches the argument. If the `mount` command finds an entry, such as the following:

```
/danger.src:
dev=/usr/src
nodename = d61server
type = nfs
mount = false
```

then it performs the mount as if you had entered the following at the command line:

```
/usr/sbin/mount -n danger -o rw,hard /usr/src /dancer.src
```

If you receive the following message:

```
mount... not in hosts database
```

a. On a network without Network Information Service (NIS), this message indicates that the host specified to the `mount` command is not in the /etc/hosts file. On a network running NIS, the message indicates that NIS could not find the host name in the /etc/hosts database or that the NIS ypbind daemon on your machine has terminated. If the /etc/resolv.conf file exists, so that the name server is being used for host name resolution, there can be a problem in the named database.

   Check the spelling and the syntax in your `mount` command. If the command is correct, and your network does not run NIS, and you only get this message for this host name, check the entry in the /etc/hosts file.

b. If your network is running NIS, make sure that the ypbind daemon is running by entering the following at the command line:

```
ps -ef | grep ypbind
```

   You should see an entry for the ypbind daemon. Try using the `rlogin` command to log in remotely to another machine, or use the `rcp` command to remote-copy something to another machine. If this also fails, your ypbind daemon is probably stopped or hung.

3. If you only get this message for this host name, you should check the /etc/hosts entry on the NIS server.

```
mount: ... server not responding: port mapper failure - RPC timed out
```

Either the server you are trying to mount from is down, or its port mapper is stopped or hung. Try restarting the inetd, portmap, and ypbind daemons.

If you cannot log in to the server remotely with the `rlogin` command, but the server is up, you should check the network connection by trying to log in remotely to some other machine. You should also check the server's network connection.

4. `1831-019 mount: ... server not responding: program not registered`

   This means that the `mount` command got through to the port mapper, but the rpc.mountd NFS mount daemon was not registered.

5. `mount: access denied...`

   Your machine name is not in the export list for the file system you are trying to mount from the server.

   You can get a list of the server's exported file systems by running the following command at the command line:

   ```
   showmount -e hostname
   ```

   If the file system you want is not in the list, or your machine name or netgroup name is not in the user list for the file system, log in to the server and check the /etc/exports file for the correct file system entry. A file system name that appears in the /etc/exports file, but not in the output from the `showmount` command, indicates a failure in the mountd daemon. Either the daemon could not parse that line in the file, it could not find the directory, or the directory name was not a locally mounted directory. If the /etc/exports file looks correct and your network runs NIS, check the server's ypbind daemon. It may be stopped or hung.

6. `mount: ...: Permission denied`

   This message is a generic indication that some part of authentication failed on the server. It may be that, in the previous example, you are not in the export list, the server could not recognize your machine's ypbind daemon, or that the server does not accept the identity you provided.

   Check the server's /etc/exports file and, if applicable, the ypbind daemon. In this case you can just change your host name with the `hostname` command and retry the `mount` command.

7. `mount: ...: Not a directory`

   Either the remote path or the local path is not a directory. Check the spelling in your command and try to run it on both the remote and local paths.

8. `mount: ...: You are not allowed`

   You must have root authority or be a member of the system group to run the `mount` command on your machine because it affects the file system for all users on that machine. NFS mounts and unmounts are only allowed for root users and members of the system group.

11.6 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. A system administrator has been working on a project for the last couple of months that requires writing different scripts on Server A. These scripts, which have been run nightly, have been collecting data within log files in a journaled file system called /project22. The system administrator would now like to access this JFS from a remote server called Server B.

   The system administrator has issued the command `lssrc -g nfs` and discovered that the daemons are inoperative on Server A. Which of the following actions should be performed in order to correct this situation?

   A. Run the `nfs.start` command.

   B. Run the `startsrc -g nfs` command.

   C. Run the `refresh -s nfsd` command.

   D. Log out and then log back into the system.

2. The same scenario from question one still applies.

   Which of the following actions should be performed by the system administrator in order to give Server B access to Server A's file system?

   A. Run the `chfs` command on Server A.

   B. Run the `chfs` command on Server B.

   C. Run the `exportfs` command on Server A.

   D. Run the `exportfs` command on Server B.

11.6.1 Answers

The following are the answers to the previous questions:

1. B
2. C

11.7 Exercises

Provided here are some exercises you may wish to perform:

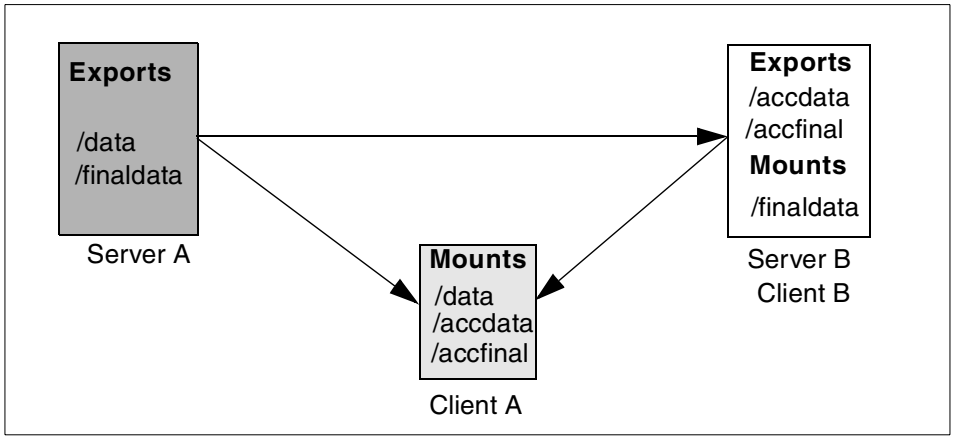

Figure 107. Exhibit for NFS Exercises

1. You are required to recreate the environment in Figure 107. Take into consideration the following:
   - Client A and Client B are allowed access to /finaldata directory.
   - /data and /accdata are predefined mounts. Use a text editor to create the /data mount in the /etc/filesystems file.
   - /finaldata is an explicit mount.
   - /accfinal is an automatic mount.
   - On Client A /data and /accdata are mounted over mount point /user/data and /user/accdata, respectively.
2. Determine the availability of NFS on each system.
3. From Client A, look at the directories exported on Server A and B, respectively.
4. Unexport /accfinal from Server B. Refresh the NFS daemons on Server B.
5. Unmount /finaldata from Client B.
6. Disallow Client A access to /finaldata on Server A.
7. Determine all automatically mounted file systems.

8. Stop NFS daemon on Server A. From Client A, try to access /data on Server A. Make note of any messages displayed. Restart the NFS daemons on Server A. Retry accessing the /data export from Client A.

Chapter 12. System Performance

For any system, continued customer satisfaction and purchasing decisions depend strongly on performance. Part of the job of the system administrator is performance analysis: to understand the system behavior and identify the usage of resources.

This section provides information on concepts, tools, and techniques for assessing and tuning the performance of AIX on RS/6000 systems. Topics covered include assessment of CPU use, memory use, disk I/O, and communications I/O. The concepts, tools, and techniques discussed in this section are not intended to be a total list, and, as such, you are encouraged to seek additional information from the appropriate AIX product documentation.

12.1 System Dynamics and Workload

An accurate and complete definition of the system's workload is critical to predicting or understanding its performance. A difference in workload can cause far more variation in the measured performance of a system than differences in CPU clock speed or RAM size. The workload definition must include not only the type and rate of requests to the system but also the exact software packages and in-house application programs to be executed.

Whenever possible, normal usage of existing applications should be observed to get authentic, real-world measurements of the rates at which users interact with their workstations or terminals.

Make sure that you include the work load that your system is doing behind the scenes. For example, if your system contains file systems that are NFS-mounted and frequently accessed by other systems, handling those accesses is probably a significant fraction of the overall workload even though your system is not officially a *server*.

12.1.1 System Dynamics

It's not enough to create the most efficient possible individual programs. In many cases, the actual programs being run were created outside of the control of the person who is responsible for meeting the organization's performance objectives. Once the application programs have been acquired or implemented as efficiently as possible, further improvement in the overall performance of the system becomes a matter of system tuning. The main components that are subject to system-level tuning are:

Fixed Disk The Logical Volume Manager (LVM) controls the placement of file systems and paging spaces on the disk, which can significantly affect the amount of seek latency the system experiences. The disk device drivers control the order in which I/O requests are acted on.

Real Memory The Virtual Memory Manager (VMM) controls the pool of free real-memory frames and determines when and from whom to steal frames to replenish the pool.

Running Thread The scheduler determines which dispatchable entity should receive control next. (In AIX Version 4, the dispatchable entity changes from a process to a thread.)

Communications I/O Depending on the type of workload and the type of communications link, it may be necessary to tune one or more of the communications device drivers, TCP/IP, or NFS.

12.1.2 Classes of Workloads

Workloads tend to fall naturally into a small number of classes. The types that follow are sometimes used to categorize systems. However, since a single system is often called upon to process multiple classes, *workload* seems more apt in the context of performance.

Workstation A workload that consists of a single user submitting work through the native keyboard and receiving results on the native display of the system. Typically, the highest-priority performance objective of such a workload is minimum response time to the user's requests.

Multiuser A workload that consists of a number of users submitting work through individual terminals. Typically, the performance objectives of such a workload are either to maximize system throughput while preserving a specified worst-case response time or to obtain the best possible response time for a fairly constant workload.

Server A workload that consists of requests from other systems. For example, a file-server workload is mostly disk read/write requests. In essence, it is the disk-I/O component of a multiuser workload (plus NFS or DFS activity); so, the same objective of maximum throughput within a given response-time limit applies. Other server workloads consist of

compute-intensive programs, database transactions, print jobs, and so on.

When a single system is processing workloads of more than one type, there must be a clear understanding between the users and the performance analyst as to the relative priorities of the possibly conflicting performance objectives of the different workloads.

12.2 Overview of System Performance

The AIX Base Operating System contains a number of monitoring and tuning tools that have historically been part of UNIX systems or are required to manage the implementation-specific features of AIX. The BOS functions and commands that are most important to performance analysts are:

`iostat` Reports CPU and I/O statistics.

`vmstat` Reports virtual-memory activity and other system statistics.

`netstat` Displays the contents of network-related data structures.

`ps` Displays the status of processes.

`lsattr` Displays the attributes of devices.

`lslv` Displays information about a logical volume or the logical volume allocations of a physical volume.

`nfsstat` Displays statistics about Network File System (NFS) and Remote Procedure Call (RPC) activity.

`nice` Runs a command at higher- or lower-than-normal priority.

`no` Displays or sets network options.

`renice` Changes the priority of one or more processes.

`reorgvg` Reorganizes the physical-partition allocation within a volume group.

`sar` Collects and reports or records system-activity information.

`time` Prints the elapsed execution time and the user and system processing time attributed to a command.

`trace` Records and reports selected system events.

In this section, a subset of these functions and commands is discussed.

12.3 Base Operation System Tools

The following commands are the focus throughout this section.

- vmstat
- iostat
- netstat

12.3.1 Using the vmstat Command

The vmstat command syntax is as follows:

```
vmstat [ -f ] [ -i ] [ -s ] [ PhysicalVolume ... ] [ Interval [ Count ] ]
```

The vmstat command reports statistics about kernel threads, virtual memory, disks, traps, and CPU activity. Reports generated by the vmstat command can be used to balance system load activity. These system-wide statistics (among all processors) are calculated either as averages for values expressed as percentages or as sums.

The PhysicalVolume parameter can be used to specify one to four names. Transfer statistics are given for each specified drive in the order specified. This count represents logical and physical requests to the physical device. It does not imply an amount of data that was read or written. Several logical requests can be combined into one physical request.

If the vmstat command is invoked without flags, the report contains a summary of the virtual memory activity since system startup. If the -f flag is specified, the vmstat command reports the number of forks since system startup. The PhysicalVolume parameter specifies the name of the physical volume.

The Interval parameter specifies the amount of time in seconds between each report. The first report contains statistics for the time since system startup. Subsequent reports contain statistics collected during the interval since the previous report. If the Interval parameter is not specified, the vmstat command generates a single report and then exits. The Count parameter can only be specified with the Interval parameter. If the Count parameter is specified, its value determines the number of reports generated and the number of seconds apart. If the Interval parameter is specified without the Count parameter, reports are continuously generated. A Count parameter of zero (0) is not allowed.

The kernel maintains statistics for kernel threads, paging, and interrupt activity, which the vmstat command accesses. The disk input/output statistics

are maintained by device drivers. For disks, the average transfer rate is determined by using the active time and number of transfers information. The percent active time is computed from the amount of time the drive is busy during the report.

Note

Both the -f and -s flags can be entered on the command line, but the system will only accept the first flag specified and will override the second flag.

Table 35 provides the key flags for the `vmstat` command.

Table 35. Key Flags for the vmstat Command

Flag	Description
-f	Reports the number of forks since system startup.
-i	Displays the number of interrupts taken by each device since system startup.
-s	Writes to standard output the contents of the sum structure, which contains an absolute count of paging events since system initialization. The -s option is exclusive of the other `vmstat` command options.

12.3.1.1 Examples

The following are some examples using the `vmstat` command.

1. To display a summary of the statistics since boot, enter `vmstat`. A sample output follows:

```
# vmstat
kthr     memory             page              faults        cpu
----- ----------- ------------------------ ------------ -----------
 r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa
 0  0 19046  1554   0   0   0   0    0   0 117  310  30  0  1 99  1
#
```

2. To display five summaries at 2-second intervals, enter `vmstat 2 5`. A sample output follows:

```
# vmstat 2 5
kthr     memory             page              faults        cpu
----- ----------- ------------------------ ------------ -----------
 r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa
 0  0 19097  1498   0   0   0   0    0   0 117  310  30  0  1 99  1
 0  0 19097  1498   0   0   0   0    0   0 121  168  34  0  1 99  0
 0  0 19097  1498   0   0   0   0    0   0 126  118  34  0  0 99  0
 0  0 19097  1498   0   0   0   0    0   0 121  118  38  0  0 99  0
 0  0 19097  1498   0   0   0   0    0   0 122  121  34  0  0 99  0
#
```

The first summary (line one of the report) contains statistics for the time since boot.

3. To display a summary of the statistics since boot, including statistics for logical disks `hdisk0` and `hdisk1`, enter: `vmstat hdisk0 hdisk1`. A sample output follows:

```
# vmstat hdisk0 hdisk1
kthr     memory             page              faults        cpu      disk xfer
----- ----------- ------------------------ ------------ ----------- -----------
 r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa  1  2  3  4
 0  0 18461  3284   0   0   0   0    0   0 117  310  30  0  1 99  1  0  0
#
```

4. To display fork statistics, enter: `vmstat -f`. A sample output follows:

```
# vmstat -f
      13887 forks
#
```

5. To display the count of various events, enter: `vmstat -s`. A sample output follows:

```
# vmstat -s
    2205645 total address trans. faults
      46745 page ins
     135567 page outs
       7088 paging space page ins
      16737 paging space page outs
          0 total reclaims
     950333 zero filled pages faults
      12659 executable filled pages faults
     233034 pages examined by clock
         15 revolutions of the clock hand
      48272 pages freed by the clock
      27557 backtracks
          0 lock misses
         10 free frame waits
          0 extend XPT waits
      38657 pending I/O waits
     163907 start I/Os
     163907 iodones
   12734979 cpu context switches
   49535570 device interrupts
          0 software interrupts
          0 traps
  130379165 syscalls
#
```

12.3.1.2 vmstat Report Output

Table 36 contains the column headings and their description for `vmstat` output.

Table 36. vmstat Output Parameters

Parameter	Description
Kthr: Kernel thread state	
r	Number of kernel threads waiting in run queue. This value is zero in an idle system and higher in a CPU bound system.
b	Number of kernel threads waiting on the wait queue (awaiting resource, awaiting input/output).
Memory: Usage of virtual and real memory	
avm	Active virtual pages, that is, the total number of pages allocated in page space. A high value is not an indicator of poor performance.
fre	Size of the free list RAM pages
Page: Page faults and paging activity	
re	Pager input/output list
pi	Pages paged in from paging space
po	Pages paged out to paging space.

Parameter	Description
fr	Pages freed (page replacement)
sr	Pages scanned by page-replacement algorithm
cy	Clock cycles by page-replacement algorithm
Faults: Trap and interrupt rate averages per second	
in	Device interrupts
sy	System calls
cs	Kernel thread context switches
Cpu: % usage of CPU time	
us	User time
sy	System time
id	CPU idle time
wa	CPU cycles to determine that the current process is wait, and there is pending disk input/output.
Disk: Provides the number of transfers per second to the specified physical volumes that occurred in the sample interval	

Note

A large portion of real memory is utilized as a cache for file system data. It is not unusual for the size of the free list to remain small.

12.3.2 Using the iostat Command

The `iostat` command syntax is as follows:

```
iostat [ -d | -t ] [ PhysicalVolume ... ] [ Interval [ Count ] ]
```

The `iostat` command is used for monitoring system input/output device loading by observing the time the physical disks are active in relation to their average transfer rates. The `iostat` command generates reports that can be used to determine what changes should be made to the system configuration to better balance the input/output load between physical disks.

The first report generated by the `iostat` command provides statistics concerning the time since the system was booted.

Each subsequent report covers the time since the previous report. All statistics are reported each time the `iostat` command is run. The report consists of a TTY and CPU header row followed by a row of TTY and CPU statistics. On multiprocessor systems, CPU statistics are calculated system-wide as averages among all processors. A disks header row is displayed followed by a line of statistics for each disk that is configured. If the PhysicalVolume parameter is specified, only those names specified are displayed.

If the PhysicalVolume parameter is specified:

- One or more physical volumes can be specified.
- The TTY and CPU reports are displayed.
- The disk report contains statistics for the specified drives.
  - If a specified logical drive name is not found,
    - the report lists the specified name and
    - displays the message `Drive Not Found`.
  - The report contains statistics for all configured disks and CD-ROMs.
    - If no drives are configured on the system, no disk report is generated.

The first character in the PhysicalVolume parameter cannot be numeric.

The Interval parameter specifies the amount of time in seconds between each report. The first report contains statistics for the time since system startup (boot). Each subsequent report contains statistics collected during the interval since the previous report.

The Count parameter can be specified in conjunction with the Interval parameter. If the Count parameter is specified, the value of count determines the number of reports generated at Interval seconds apart. If the Interval parameter is specified without the Count parameter, the `iostat` command generates reports continuously.

The `iostat` command is useful in determining whether a physical volume is becoming a performance bottleneck and if there is potential to improve the situation. The % utilization field for the physical volumes indicates how evenly the file activity is spread across the drives. A high percentage utilization on a physical volume is a clear indication that there may be contention for this resource. Since the CPU utilization statistics are also available with the `iostat` report, the percentage of time the CPU is in I/O wait can be determined at the same time. Consider distributing data across drives if the

I/O wait time is significant, and the disk utilization is not evenly distributed across volumes.

Note

Some system resource is consumed in maintaining disk I/O history for the `iostat` command. Use the sysconfig subroutine or SMIT to stop history accounting

Table 37 provides a list of common `iostat` command flags.

Table 37. Key Flags for the iostat Command

Flag	Description
-d	The -d option is exclusive of the -t option and displays only the disk utilization report.
-t	The -t option is exclusive of the -d option and displays only the TTY and CPU usage reports.

12.3.2.1 Examples

The following are examples of the `iostat` command usage.

1. To display a single history since boot report for all tty, CPU, and Disks, enter:

```
#iostat
tty:      tin         tout   avg-cpu:  % user    % sys     % idle    % iowait
          0.1         32.9                5.9     17.0       32.3      44.8

Disks:        % tm_act     Kbps      tps    Kb_read   Kb_wrtn
hdisk1           3.7      34.5       1.9       4664       128
hdisk0          46.5     526.3      40.2      68116      5048
cd0              0.0       0.0       0.0          0         0
#
```

2. To display a continuous disk report at two second intervals for the disk with the name `hdisk1`, enter:

```
iostat -d hdisk1 2
```

3. To display six reports at two second intervals for the disk with the logical name `hdisk1`, enter:

```
iostat -d hdisk1 2 6
```

4. To display six reports at two second intervals for all disks, enter:

```
iostat -d 2 6
```

5. To display six reports at two second intervals for three disks named `disk1`, `disk2`, `disk3`, enter:

```
iostat -d disk1 disk2 disk3 2 6
```

12.3.2.2 iostat Report Output

The `iostat` command generates two types of reports, the tty and CPU Utilization report and the Disk Utilization report. The meaning of the output parameters is shown in Table 38.

Table 38. iostat Output Parameters

Parameter	Description
TTY and CPU Utilization Report: The first report generated by the `iostat` command is the TTY and CPU Utilization Report. For multiprocessor systems, the CPU values are global averages among all processors. Also, the I/O wait state is defined system-wide and not per processor. This information is updated at regular intervals by the kernel (typically sixty times per second). The TTY report provides a collective account of characters per second received from all terminals on the system as well as the collective count of characters output per second to all terminals on the system. The report gives the following information:	
tin	Shows the total number of characters read by the system for all TTYs.
tout	Shows the total number of characters written by the system to all TTYs.
% user	Shows the percentage of CPU utilization that occurred while executing at the user level (application).
% sys	Shows the percentage of CPU utilization that occurred while executing at the system level (kernel).
% idle	Shows the percentage of time that the CPU or CPUs were idle, and the system did not have an outstanding disk I/O request.
% iowait	Shows the percentage of time that the CPU or CPUs were idle during which the system had an outstanding disk I/O request. This value may be slightly inflated if several processors are idling at the same time. This is an unusual occurance.
Disk Utilization Report: The second report generated by the `iostat` command is the Disk Utilization Report. The disk report provides statistics on a per physical disk basis. The report has a format similar to the following:	

Parameter	Description
% tm_act	Indicates the percentage of time the physical disk was active (bandwidth utilization for the drive).
Kbps	Indicates the amount of data transferred (read or written) to the drive in KB per second.
tps	Indicates the number of transfers per second that were issued to the physical disk. A transfer is an I/O request to the physical disk. Multiple logical requests can be combined into a single I/O request to the disk. A transfer is of indeterminate size.
Kb_read	The total number of KB read.
Kb_wrtn	The total number of KB written.

For large system configurations where a large number of disks are configured, the system can be configured to avoid collecting physical disk input/output statistics when the `iostat` command is not executing. If the system is configured in the above manner, the first Disk report displays the message Disk History Since Boot Not Available instead of the disk statistics. Subsequent interval reports generated by the `iostat` command contain disk statistics collected during the report interval. Any TTY and CPU statistics after boot are unaffected. If a system management command is used to re-enable disk statistics, the first `iostat` command report displays activity from the interval starting at the point that disk input/output statistics were enabled.

12.3.3 Using the netstat Command

The `netstat` command syntax is as follows:

To display active sockets for each protocol or routing table information:

```
/bin/netstat [ -n ] [ { -A -a } | { -r -i -I Interface } ] [ -f
AddressFamily ] [ -p Protocol ] [ Interval ] [ System ]
```

To display the contents of a network data structure:

```
/bin/netstat [ -m | -s | -u | -v ] [ -f AddressFamily ] [ -p Protocol ] [
Interval ] [ System ]
```

To display the packet counts throughout the communications subsystem:

```
/bin/netstat -D
```

The `netstat` command (Table 39) symbolically displays the contents of various network-related data structures for active connections. The Interval

parameter, specified in seconds, continuously displays information regarding packet traffic on the configured network interfaces. The Interval parameter takes no flags. The System parameter specifies the memory used by the current kernel. Unless you are looking at a dump file, the System parameter should be /unix.

Table 39. Key Flags for the netstat Command

Flag	Description
-r	Shows the routing tables. When used with the -s flag, the -r flag shows routing statistics.
-s	Shows statistics for each protocol.

Note

In the statistics output, a N/A displayed in a field value indicates the count is not applicable. For the NFS/RPC statistics, the number of incoming packets that pass through RPC are the same packets that pass through NFS; so, these numbers are not summed in the NFS/RPC Total field, thus, the N/A. NFS has no outgoing packet or outgoing packet drop counters specific to NFS and RPC. Therefore, individual counts have a field value of N/A, and the cumulative count is stored in the NFS/RPC Total field.

The collision count for Ethernet interfaces is not supported.

12.3.3.1 Examples

The following are examples of `netstat` command usage.

To display the routing table, use the command:

```
# netstat -r
Routing tables
Destination      Gateway           Flags   Refs     Use  If   PMTU  Exp  Groups

Route Tree for Protocol Family 2 (Internet):
default          itsorusi.itsc.aus UG       14      706  tr0     -   -
9.3/16           sv1051c.itsc.aust U         0        5  en0     -   -
9.3.1/24         sv1051c.itsc.aust U        40     2616  tr0     -   -
127/8            localhost         U         3      180  lo0     -   -
192.168.1/24     sv1166f.itsc.aust UG        0        0  tr0     -   -

Route Tree for Protocol Family 24 (Internet v6):
::1              ::1               UH        0        0  lo0 16896   -
#
```

To display the routing statistics use the command:

```
# netstat -r -s
routing:
```

```
        0 bad routing redirect
        0 dynamically created route
        0 new gateway due to redirects
        0 destination found unreachable
        0 use of a wildcard route
#
```

12.3.3.2 netstat Output Report

The default display for active sockets shows the following items:

- Local and remote addresses
- Send and receive queue sizes (in bytes)
- Protocol
- Internal state of the protocol

Internet address formats are of the form host.port or network.port if a socket's address specifies a network but no specific host address. The host address is displayed symbolically if the address can be resolved to a symbolic host name while network addresses are displayed symbolically according to the /etc/networks file.

NS addresses are 12-byte quantities consisting of a 4-byte network number, a 6-byte host number, and a 2-byte port number, all of which are stored in network standard format. For VAX architecture, these are word and byte reversed; for the Sun systems, they are not reversed.

If a symbolic name for a host is not known, or if the -n flag is used, the address is printed numerically according to the address family. Unspecified addresses and ports appear as an * (asterisk).

Interface Display (`netstat -i`)

The interface display format provides a table of cumulative statistics for the following items:

- Errors
- Collisions

  The collision count for Ethernet interfaces is not supported.
- Packets transferred

  The interface display also provides the:

  - interface name,
  - number, and
  - address, as well as

- the maximum transmission units (MTUs).

Routing Table Display (`netstat -r`)

The routing table display format indicates the available routes and their statuses. Each route consists of a destination host or network and a gateway to use in forwarding packets. The routing table contains the following ten fields:

Flags
The flags field of the routing table shows the state of the route:

U Up.

H The route is to a host rather than to a network.

G The route is to a gateway.

D The route was created dynamically by a redirect.

M The route has been modified by a redirect.

L The link-level address is present in the route entry.

c Access to this route creates a cloned route. This field only applies to AIX Version 4.2.1 or later.

W The route is a cloned route. This field only applies to AIX Version 4.2.1 or later

Direct routes are created for each interface attached to the local host.

Gateway The gateway field for these entries shows the address of the outgoing interface.

Refs Gives the current number of active uses for the route. Connection-oriented protocols hold onto a single route for the duration of a connection, while connectionless protocols obtain a route while sending to the same destination.

Use Provides a count of the number of packets sent using that route.

PMTU Gives the Path Maximum Transfer Unit (PMTU). This field only applies to AIX Version 4.2.1 or later.

Interface Indicates the network interfaces utilized for the route.

Exp Displays the time (in minutes) remaining before the route expires. This field only applies to AIX Version 4.2.1 or later.

Groups Provides a list of group IDs associated with that route. This field only applies to AIX Version 4.2.1 or later.

Netmasks Lists the netmasks applied on the system.

12.4 Performance Analysis

In this section, system performance is analyzed to determine whether a system is CPU bound or memory bound. There is also a discussion on the idle time for Symmetric Multiprocessors (SMP) and Uniprocessor (UP) systems.

The following are some terms used during this discussion.

CPU bound A system is said to be CPU-bound if the total system (sy) and user (us) CPU usage is approaching 100 percent. This would imply that idle time and wait time for CPU are approaching zero.

Memory bound A system is memory-bound if some virtual memory is forced out to disk, meaning the system is waiting on relatively slow disk instead of relatively fast RAM. This is indicated by a non-zero value in page-in (pi) and page-out (po) values.

12.4.1 Determining CPU Bound and Memory Bound Systems

Using the output from the `vmstat` command, the values for the sy and us columns is used to continue with this discussion.

You need to obtain a preliminary look at the performance of the system as shown in Figure 108.

```
# vmstat 5 5
kthr     memory             page              faults        cpu
----- ----------- ------------------------ ------------ -----------
 r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa
 0  0 22988   123   0   0   0   1    8   0 130  383  39  1  1 96  2
 2  0 23318   158   0   2   1  80  331   0 188 1945 339 66 31  0  3
 2  0 23213   332   0   0   0  11   98   0 224 1783 375 77 23  0  0
 4  0 23390   274   0   2   0  32  208   0 202 2247 366 60 40  0  0
 3  0 23449   157   0  11   0   0    0   0 270 5308 1078 88 12  0  0
#
```

Figure 108. vmstat Report of CPU-Bound System

In this section, you will look at the sy and us columns for the CPU usage to determine if the system was CPU-bound during the time the `vmstat` command was gathering system information.

Remember that a system is CPU-Bound if the Total system and user CPU usage approaches 100 percent.

For rows two through Five, the System +User CPU Usage are:

Row 2 =(66+31)%=97% and r = 2

Row 3 =(77+23)%=100% and r = 2

Row 4 =(60+40)%=100% and r = 4

Row 5 =(88+12)%=100% and r = 3

There are two indications that this system is CPU-bound.

- The CPU Usage values tend towards 100 percent, and
- the r values are nonzero indicating that the CPU has more work to perform. This is mentioned previously, as an indicator for CPU activity, in 12.3.1.2, “vmstat Report Output” on page 297.

To determine if a system is memory bound, the pi and po columns are taken into consideration. As defined in 12.4, “Performance Analysis” on page 306, a system is memory bound if the average page in rate (pi) for paging spaces and the average page out rate (po) for paging spaces were non-zero.

12.4.2 Idle Time Calculations

Idle time calculations on an Symmetric Multiprocessor and an Uniprocessor system are the same. In an SMP environment, the output received from the `vmstat` and `iostat` commands are a summary of the system wait and idle time across all processors. Therefore, need only use the tools as laid out in the previous sections and calculating the system idle time based on the output received.

When calculating total system idle time over an interval, both the percentage of idle time(id), and the percentage of wait time (wa) are to be considered. Both fields are obtained from the `vmstat` command output.

Note

Total CPU Idle Time % = wait % + Idle Time %

In order to calculate the time that the system is idle using the output from the `vmstat` command, perform the following:

1. Calculate the average percentage idle time over the interval.

Given the following output from an SMP system, calculate the system idle time from the command `vmstat 900 4`, that is, an output every 900 seconds or (15 minutes) four times.

```
kthr     memory             page              faults        cpu
----- ----------- ------------------------ ------------ -----------
 r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa
 0  0 11015 205693   0   0   0   0    0   0 102   11   6  0  0 99  1
 0  1 13014 203638   0   0   0   0    0   0 513  202 233  0  0 97  2
 0  1 13903 202718   0   0   0   0    0   0 528  256 262  0  0 95  4
 0  1 13008 203613   0   0   0   0    0   0 509  178 225  0  0 99  1
```

Average CPU Idle Time percentage = Sum (%Idle Times(id) + %wait)/ # readings, therefore, the Average CPU Idle Time percentage = ((99+1) + (97+2) + (95+4) + (99+1))/4 = 99.5%

2. Then calculate the Total CPU Idle Time in minutes.

   These readings were obtained over one hour, therefore, total CPU Idle Time for this system = 99.5% x 60 minutes = ~59 minutes

12.4.3 Calculating Paging Rate

Paging rate is the average number of page-ins and page-outs per CPU cycle.

If the pagein/pageout (pi/po) ratio is greater than one, it is indicating that for every pagein there has to be at least one pageout and, therefore, points to high paging activities. This system is, therefore, said to have a high paging rate.

12.5 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. A system administrator is experiencing performance problems and runs the `vmstat` command. The output of `vmstat` is shown in the following exhibit.

```
procs    memory             page              faults        cpu
----- ----------- ------------------------ ------------ -----------
r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa
2  0 22534  1465   0   0   0   0    0   0 238  903 239 77 23  0  0
2  0 22534  1445   0   0   0   0    0   0 209 1142 205 72 28  0  0
2  0 22534  1426   0   0   0   0    0   0 189 1220 212 74 26  0  0
3  0 22534  1410   0   0   0   0    0   0 255 1704 268 70 30  0  0
2  1 22557  1365   0   0   0   0    0   0 383  977 216 72 28  0  0
```

What can be concluded from this output?

A. The machine is CPU bound.

B. The machine needs memory optimized.

C. The machine needs a FDDI card installed.

D. A user program is causing unnecessary paging.

2. A system administrator runs the `vmstat` command. The output of `vmstat` is shown in the following exhibit (using a 15 minute interval).

```
kthr     memory             page              faults        cpu
----- ----------- ------------------------ ------------ -----------
 r  b   avm   fre  re  pi  po  fr   sr  cy  in   sy  cs us sy id wa
 2  0  9200 11027   0   0   0   0    0   0 103   52  14 14 16  0 69
 2  1  9200 11027   0   0   0   0    0   0 207  251  29 12 11  0 67
 3  1  9200 11027   0   0   0   0    0   0 207  120  29  9 11  0 80
 5  1  9200 11027   0   0   0   0    0   0 206  120  29 13  5  0 79
 4  1  9200 11027   0   0   0   0    0   0 207  131  32  9  8  0 72
```

Based on this output, what is the average CPU idle time in minutes?

A. 45.5

B. 75.3

C. 44.04

D. 73.4

12.5.1 Answers

The following are the answers to the previous questions:

1. A
2. D

12.6 Exercises

Provided here are some exercises you may wish to perform:

1. Gather statistics using the `vmstat`, `iostat`, and `netstat` commands. Take a look at your system performance.
2. Calculate your systems idle time (in minutes) and the paging rate.
3. Determine if your system is CPU bound or memory bound.

Chapter 13. User Administration

This chapter discusses user administration that consists of creating and removing user accounts, defining and changing user attributes, and the important files referenced during user administration.

13.1 Overview

Users are the primary agents on the system. Each user is required to log in to the system. The user supplies the user name of an account and a password if the account has one (on a secure system, all accounts either have passwords or are invalidated). If the password is correct, the user is logged in to that account; the user acquires the access rights and privileges of the account. The /etc/passwd and /etc/security/passwd files maintain user passwords.

Groups are collections of users who can share access permissions for protected resources. A group has an ID, and a group is composed of members and administrators. The creator of the group is usually the first administrator. There are three types of groups:

User Group User groups should be made for people who need to share files on the system, such as people who work in the same department or people who are working on the same project. In general, create as few user groups as possible.

System Admin. Groups System administrators groups correspond to the SYSTEM group. SYSTEM group membership allows an administrator to perform some system maintenance tasks without having to operate with root authority.

System-Defined Groups There are several system-defined groups. The STAFF group is the default group for all nonadministrative users created in the system. You can change the default group by using the `chsec` command to edit the /usr/lib/security/mkuser.default file. The SECURITY group is a system-defined group having limited privileges for performing security administration.

An attribute is a characteristic of a user or a group that defines the type of functions that a user or a group can perform. These can be extraordinary

privileges, restrictions, and processing environments assigned to a user. Their attributes control their access rights, environment, how they are authenticated, and how, when, and where their accounts can be accessed. These attributes are created from default values when a user is created through the `mkuser` command. They can be altered by using the `chuser` command.

Some users and groups can be defined as administrative. These users and groups can be created and modified only by the root user.

13.2 User Administration Related Commands

The following are few of the important commands used for user administration.

`mkuser`	Creates a new user.
`passwd`	Creates or changes the password of user.
`chuser`	Changes user attributes (except password).
`lsuser`	Lists user attributes.
`rmuser`	Removes a user and its attributes.
`chsec`	Changes security related stanzas.
`login`	Initiates a user session.
`who`	Identifies the users currently logged in.
`dtconfig`	Enables or disables the desktop autostart feature.

13.3 User Administration Related Files

The following files are referenced while doing user administration.

/etc/security/environ	Contains the environment attributes for users.
/etc/security/lastlog	Contains the last login attributes for users.
/etc/security/limits	Contains process resource limits for users.
/etc/security/user	Contains extended attributes for users.
/usr/lib/security/mkuser.default	Contains the default attributes for new users.
/etc/passwd	Contains the basic attributes of users.

/etc/security/passwd	Contains password information.
/etc/security/login.cfg	Contains configuration information for login and user authentication.
/etc/utmp	Contains the record of users logged into the system.
/var/adm/wtmp	Contains connect time accounting records.
/etc/security/failedlogin	Records all failed login attempts.
/etc/motd	Contains the message to be displayed every time a user logs in to the system.
/etc/environment	Specifies the basic environment for all processes.
/etc/group	Contains the basic attributes of groups.
/etc/security/group	Contains the extended attributes of groups.

13.3.1 /etc/security/environ

The /etc/security/environ file is an ASCII file that contains stanzas with the environment attributes for users. Each stanza is identified by a user name and contains attributes in the Attribute=Value form with a comma separating the attributes. Each line is ended by a new-line character, and each stanza is ended by an additional new-line character. If environment attributes are not defined, the system uses default values.

The `mkuser` command creates a user stanza in this file. The initialization of the attributes depends upon their values in the /usr/lib/security/mkuser.default file. The `chuser` command can change these attributes, and the `lsuser` command can display them. The `rmuser` command removes the entire record for a user.

A typical /etc/security/environ file is shown in the following example which has no environment attributes defined. Therefore, the system is using default values.

```
# pg /etc/security/environ
default:
root:
daemon:
bin:
```

```
sys:
adm:
uucp:
guest:
```

13.3.2 /etc/security/lastlog

The /etc/security/lastlog file is an ASCII file that contains stanzas with the last login attributes for users. Each stanza is identified by a user name and contains attributes in the Attribute=Value form. Each attribute is ended by a new-line character, and each stanza is ended by an additional new-line character. Two stanzas for users (root & john) are shown in Figure 109.

The `mkuser` command creates a user stanza in the lastlog file. The attributes of this user stanza are initially empty. The field values are set by the `login` command as a result of logging in to the system. The `lsuser` command displays the values of these attributes; the `rmuser` command removes the user stanza from this file along with the user account.

```
root:
        time_last_login = 909674976
        tty_last_login = /dev/pts/7
        host_last_login = sv1166a.itsc.austin.ibm.com
        unsuccessful_login_count = 0
        time_last_unsuccessful_login = 909608576
        tty_last_unsuccessful_login = /dev/pts/2
        host_last_unsuccessful_login = sv1121c


john:
        time_last_unsuccessful_login = 909529946
        tty_last_unsuccessful_login = /dev/pts/2
        host_last_unsuccessful_login = sv1121c

        unsuccessful_login_count = 0
        time_last_login = 909529992
        tty_last_login = /dev/pts/2
        host_last_login = sv1121c

~
~
```

Figure 109. /etc/security/lastlog Stanzas

13.3.3 /etc/security/limits

The /etc/security/limits file is an ASCII file that contains stanzas that specify the process resource limits for each user. These limits are set by individual attributes within a stanza.

Each stanza is identified by a user name followed by a colon and contains attributes in the Attribute=Value form. Each attribute is ended by a new-line character, and each stanza is ended by an additional new-line character. If you do not define an attribute for a user, the system applies default values.

The default attributes and attributes for a user smith are shown in Figure 110 on page 315.

When you create a user with the `mkuser` command, the system adds a stanza for the user to the limits file. Once the stanza exists, you can use the `chuser` command to change the user's limits. To display the current limits for a user, use the `lsuser` command. To remove users and their stanzas, use the `rmuser` command.

```
default:
        fsize = 2097151
        core = 2097151
        cpu = -1
        data = 262144
        rss = 65536
        stack = 65536
        nofiles = 2000

smith:
        fsize = 3007151
        data = 332144
        data_hard = 3400000

~
~
~
~
~
~
~
~
```

Figure 110. Contents of /etc/security/limits File

13.3.4 /etc/security/user

The /etc/security/user file contains extended user attributes. This is an ASCII file that contains attribute stanzas for users. The `mkuser` command creates a stanza in this file for each new user and initializes its attributes with the default attributes defined in the /usr/lib/security/mkuser.default file.

Each stanza in the /etc/security/user file is identified by a user name, followed by a colon (:), and contains comma-separated attributes in the Attribute=Value form. If an attribute is not defined for a user, either the default

stanza or the default value for the attribute is used. You can have multiple default stanzas in the /etc/security/group file. A default stanza applies to all of the stanzas that follow but does not apply to the stanzas preceding it.

Each attribute is ended by a new-line character, and each stanza is ended by an additional new-line character.

The `mkuser` command creates an entry for each new user in the /etc/security/user file and initializes its attributes with the attributes defined in the /usr/lib/security/mkuser.default file. To change attribute values, use the `chuser` command. To display the attributes and their values, use the `lsuser` command. To remove a user, use the `rmuser` command.

13.3.5 /usr/lib/security/mkuser.default

The /usr/lib/security/mkuser.default file contains the default attributes for new users. This file is an ASCII file that contains user stanzas. These stanzas have attribute default values for users created by the `mkuser` command. Each attribute has the Attribute=Value form. If an attribute has a value of $USER, the `mkuser` command substitutes the name of the user. The end of each attribute pair and stanza is marked by a new-line character.

There are two stanzas, `user` and `admin`, that can contain all defined attributes except the ID and admin attributes. The `mkuser` command generates a unique ID attribute. The `admin` attribute depends on whether the -a flag is used with the `mkuser` command. The following example shows a typical stanza in `/usr/lib/security/mkuser.default`.

```
# pg /usr/lib/security/mkuser.default

user:
        pgrp = staff
        groups = staff
        shell = /usr/bin/ksh
        home = /home/$USER

admin:
        pgrp = system
        groups = system
        shell = /usr/bin/ksh
        home = /home/$USER
```

13.3.6 /etc/passwd

The /etc/passwd file contains basic user attributes. This is an ASCII file that contains an entry for each user. Each entry defines the basic attributes applied to a user.

When you use the `mkuser` command to add a user to your system, the command updates the /etc/passwd file.

An entry in the /etc/passwd file has the following form with all attributes separated by a colon(:).

```
Name:Password: UserID:PrincipleGroup:Gecos: HomeDirectory:Shell
```

Password attributes can contain an asterisk (*) indicating an invalid password or an exclamation point (!) indicating that the password is in the /etc/security/passwd file. Under normal conditions, the field contains an exclamation point (!). If the field has an asterisk (*) and a password is required for user authentication, the user cannot log in.

The shell attribute specifies the initial program or shell (login shell) that is executed after a user invokes the `login` command or `su` command. The Korn shell is the standard operating system login shell and is backwardly compatible with the Bourne shell. If a user does not have a defined shell, /usr/bin/sh, the system default shell (Bourne shell) is used. The Bourne shell is a subset of the Korn shell.

The `mkuser` command adds new entries to the /etc/passwd file and fills in the attribute values as defined in the /usr/lib/security/mkuser.default file. The Password attribute is always initialized to an asterisk (*), which is an invalid password. You can set the password with the `passwd` or `pwdadm` commands. When the password is changed, an exclamation point (!) is added to the /etc/passwd file indicating that the encrypted password is in the /etc/security/passwd file.

Use the `chuser` command to change all user attributes except Password. The `chfn` command and the `chsh` command change the Gecos attribute and Shell attribute, respectively. To display all the attributes in this file, use the `lsuser` command. To remove a user and all the user's attributes, use the `rmuser` command.

The contents of /etc/passwd file in Figure 111 shows that the Password attributes for two users (john and bob) are ! and *, respectively, which implies that bob cannot login as it has invalid password.

```
# pg /etc/passwd
root:!:0:0::/:/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::/:
imnadm:*:200:200::/home/imnadm:/usr/bin/ksh
john:!:210:1::/home/john:/usr/bin/ksh
bob:*:213:1::/home/bob:/usr/bin/ksh
# 
```

Figure 111. Contents of /etc/passwd File

13.3.7 /etc/security/passwd

The /etc/security/passwd file is an ASCII file that contains stanzas with password information. Each stanza is identified by a user name followed by a colon (:) and contains attributes in the form Attribute=Value. Each attribute is ended with a new line character, and each stanza is ended with an additional new line character.

Although each user name must be in the /etc/passwd file, it is not necessary to have each user name listed in the /etc/security/passwd file. A typical file would have contents as shown in Figure 112.

```
root:
        password = .qKD2SmeIpoJo
        lastupdate = 904940604
        flags =

sys:
        password = *

adm:
        password = *

guest:
        password = *

lpd:
        password = *

john:
        password = 05.g0AdV0RKB.
        lastupdate = 909529992
        flags =
```

Figure 112. Contents of /etc/security/passwd File

13.3.8 /etc/security/login.cfg

The /etc/security/login.cfg file (Figure 113) is an ASCII file that contains stanzas of configuration information for login and user authentication. Each stanza has a name, followed by a : (colon). Attributes are in the form Attribute=Value. Each attribute ends with a new-line character, and each stanza ends with an additional new-line character. There are three types of stanzas.

port stanza	Defines the login characteristics of ports.
authentication stanza	Defines the authentication methods for users.
user configuration stanza	Defines programs that change user attributes (usw).

```
default:
        sak_enabled = false
        logintimes =
        logindisable = 0
        logininterval = 0
        loginreenable = 0
        logindelay = 0

auth_method:
        program =

usw:
        shells = /bin/sh,/bin/bsh,/bin/csh,/bin/ksh,/bin/tsh,/usr/bin/sh,/usr/bi
n/bsh,/usr/bin/csh,/usr/bin/ksh,/usr/bin/tsh,/usr/sbin/sliplogin
        maxlogins = 2
        logintimeout = 60

~
~
~
~
~
~
```

Figure 113. Contents of /etc/security/login.cfg File

13.3.9 /etc/utmp, /var/adm/wtmp, /etc/security/failedlogin

The utmp file, the wtmp file, and the failedlogin file contain records with user and accounting information. When a user successfully logs in, the login program writes entries in two files.

- The /etc/utmp file, which contains a record of users logged into the system. The command `who -a` processes the /etc/utmp file, and if this file is corrupted or missing, no output is generated from the `who` command.
- The /var/adm/wtmp file (if it exists), which contains connect-time accounting records.

On an invalid login attempt, due to an incorrect login name or password, the login program makes an entry in the /etc/security/failedlogin file, which contains a record of unsuccessful login attempts.

13.3.10 /etc/motd

The message of the day is displayed every time a user logs in to the system. It is a convenient way to communicate information to all users, such as installed software version numbers or current system news. The message of the day is contained in the /etc/motd file. To change the message of the day, simply edit that file.

A typical /etc/motd file contents would look like Figure 114 on page 321.

```
# pg /etc/motd
*******************************************************************************
*                                                                             *
*                                                                             *
*  Welcome to AIX Version 4.3!                                                *
*                                                                             *
*                                                                             *
*  Please see the README file in /usr/lpp/bos for information pertinent to    *
*  this release of the AIX Operating System.                                  *
*                                                                             *
*                                                                             *
*******************************************************************************
# 
```

Figure 114. Sample etc/motd File

13.3.11 /etc/environment

The /etc/environment file contains variables specifying the basic environment for all processes. When a new process begins, the exec subroutine makes an array of strings available that have the form Name=Value. This array of strings is called the environment. Each name defined by one of the strings is called an environment variable or shell variable. Environment variables are examined when a command starts running.

When you log in, the system sets environment variables from the environment file before reading your login profile, .profile. Following are a few variables that make up part of the basic environment.

HOME The full path name of the user login or HOME directory. The login program sets this to the name specified in the /etc/passwd file.

LANG The locale name currently in effect. The LANG variable is set in the /etc/environment file at installation time.

PATH The sequence of directories that commands, such as the `sh`, `time`, `nice`, and `nohup` commands search when looking for a command whose path name is incomplete. The directory names are separated by colons.

TZ The time-zone information. The TZ environment variable is set by the /etc/environment file.

13.4 User Administration Tasks

User administration creates users, defines or changes their attributes, and defines security environment for the users. These topics are discussed in the following sections.

13.4.1 Adding a New User Account

The `mkuser` command creates a new user account. The Name parameter must be a unique 8-byte or less string. By default, the `mkuser` command creates a standard user account. To create an administrative user account, specify the -a flag.

The `mkuser` command does not create password information for a user, and, therefore, the new accounts are disabled until the `passwd` command is used to add authentication information to the /etc/security/passwd file. The `mkuser` command only initializes the Password attribute of /etc/passwd file with an * (asterisk).

- The following example shows the command to create a user account, `smith` with the default values in the /usr/lib/security/mkuser.default file.

  ```
  mkuser smith
  ```

  Alternatively, you can use SMIT:

  a. Executing `smitty mkuser` will prompt you to a menu as shown in Figure 115.

  b. Type `smith` for the field User NAME.

  c. Press the **Enter** to create the user.

d. When SMIT returns an OK prompt, Press the **F10** key to return to the command prompt.

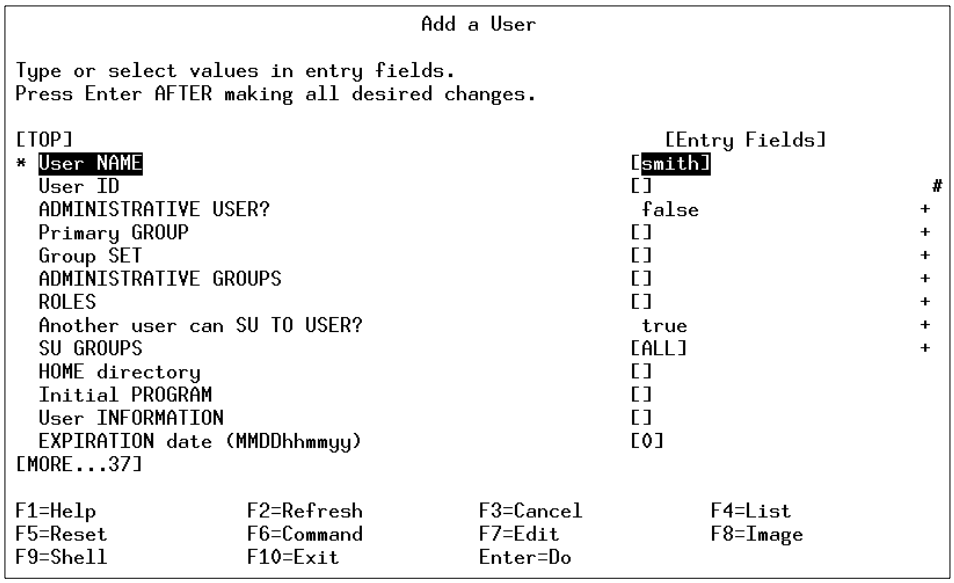

Figure 115. Adding a User

- To create the smith account with `smith` as an administrator, enter:

  ```
  mkuser -a smith
  ```

  You must be the root user to create `smith` as an administrative user.

- To create the smith user account and set the `su` attribute to a value of `false` enter:

  ```
  mkuser su=false smith
  ```

13.4.2 Creating or Changing User Password

The `passwd` command will create an encrypted passwd entry in /etc/security/passwd and change the Password attribute of /etc/passwd from * to ! (exclamation).

You could also use the (SMIT) `smit mkuser` fast path to run this command.

- The following example shows the command to change your password.

  ```
  passwd
  ```

  The `passwd` command prompts you for your old password, if it exists and you are not the root user. After you enter the old password, the command prompts you twice for the new password.

Alternatively, you can use SMIT:

a. Executing `smitty passwd` will prompt you to a menu as shown in Figure 116.

b. Type `smith` for the field `User NAME`.

c. Press **Enter,** and you will prompted to enter the new password (twice) as shown in Figure 117.

d. Enter the new password and press the **Enter** key.

e. When SMIT returns an OK prompt, press the **F10** key to return to command prompt.

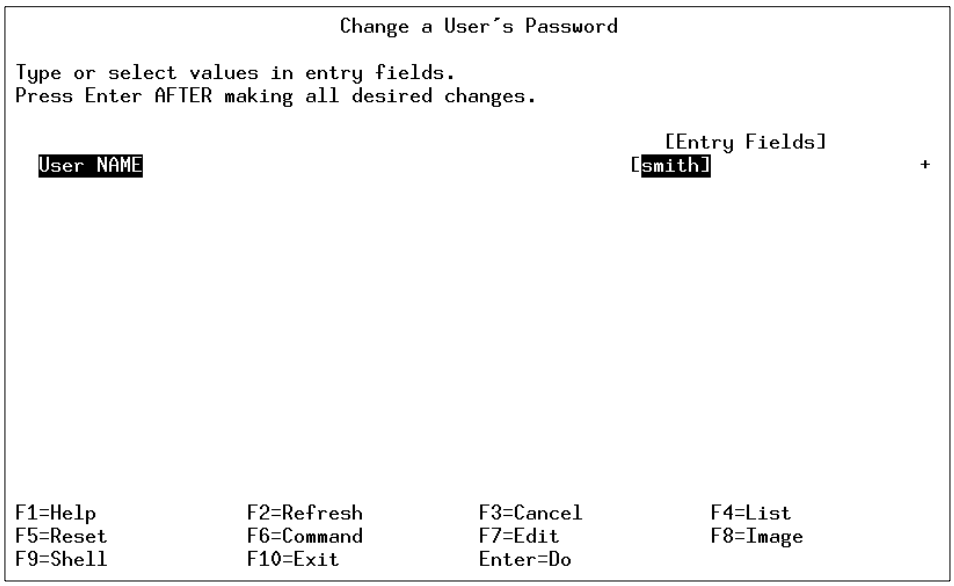

Figure 116. Changing a User Password

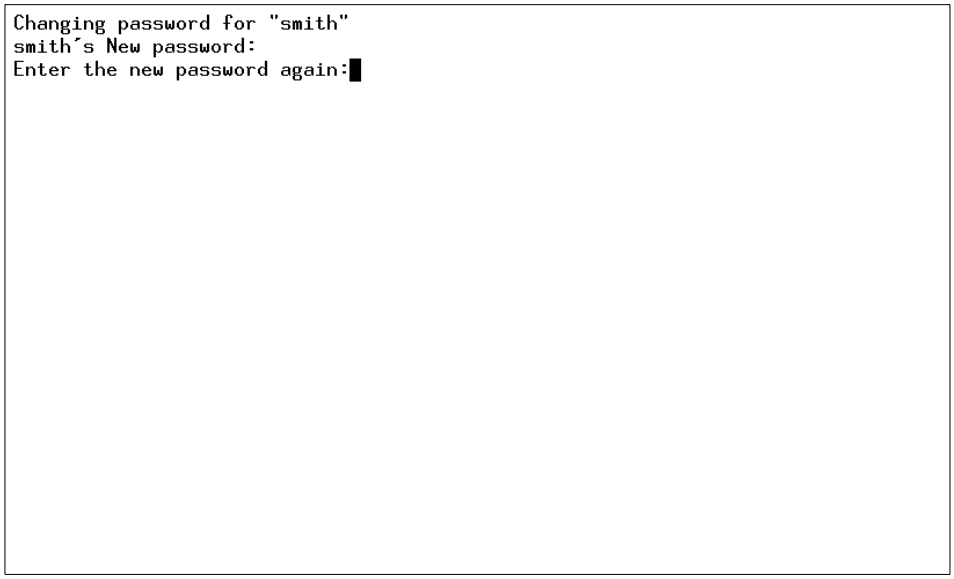

Figure 117. Entering a User Password

- To change your full name in the /etc/passwd file, enter:

  `passwd -f smith`

  The `passwd` command displays the name stored for your user ID. For example, for login name smith, the `passwd` command could display the message as shown in the following example.

  ```
  # passwd -f smith
   smith's current gecos:
                 "Mr J.Smith"
   Change (yes) or (no)? > n
   Gecos information not changed.
  ```

  If you enter a Y for yes, the `passwd` command prompts you for the new name. The `passwd` command records the name you enter in the /etc/passwd file.

13.4.3 Changing User Attributes

The `chuser` command changes attributes for the user identified by the Name parameter. The user name must already exist as an alphanumeric string of eight bytes or less.

Note

Do not use the `chuser` command if you have a Network Information Service (NIS) database installed on your system.

Only the root user can use the `chuser` command to perform the following tasks:

- Make a user an administrative user by setting the admin attribute to true.
- Change any attributes of an administrative user.
- Add a user to an administrative group.

The following examples show the use of the `chuser` command with various flags.

- To enable user `smith` to access this system remotely, enter:

  ```
  chuser rlogin=true smith
  ```

- To change the expiration date for the smith user account to 8 a.m., 1 December, 1998, enter:

  ```
  chuser expires=1201080098 smith
  ```

- To add `smith` to the group programers, enter:

  ```
  chuser groups=programers smith
  ```

  Alternatively, you can go through the SMIT hierarchy by:

  a. Executing `smitty chuser` will prompt you to a menu as shown in Figure 118.

  b. Type `smith` for the field `User NAME`.

  c. Use the Arrows key to highlight the Primary GROUP field and type programmer in it.

  d. Press **Enter.**

  e. When SMIT returns an OK prompt, press the **F10** key to return to the command prompt.

```
                    Change / Show Characteristics of a User

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

[TOP]                                                  [Entry Fields]
  User NAME                                           smith
  User ID                                             [218]                  #
  ADMINISTRATIVE USER?                                 false                 +
  Primary GROUP                                       [program]              +
  Group SET                                           [staff]                +
  ADMINISTRATIVE GROUPS                               []                     +
  ROLES                                               []                     +
  Another user can SU TO USER?                         true                  +
  SU GROUPS                                           [ALL]                  +
  HOME directory                                      [/home/smith]
  Initial PROGRAM                                     [/usr/bin/ksh]
  User INFORMATION                                    []
  EXPIRATION date (MMDDhhmmyy)                        [0]
[MORE...37]

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

Figure 118. Changing User Characteristics

13.4.4 Displaying User Attributes

The `lsuser` command displays the user account attributes. You can use this command to list all attributes of all the users or all the attributes of specific users except their passwords. Since there is no default parameter, you must enter the ALL keywords to see the attributes of all the users. By default, the `lsuser` command displays all user attributes. To view selected attributes, use the -a List flag. If one or more attributes cannot be read, the `lsuser` command lists as much information as possible.

Note-NIS Users

If you have a Network Information Service (NIS) database installed on your system, some user information may not appear when you use the `lsuser` command.

By default, the `lsuser` command lists each user's attributes on one line. It displays attribute information as Attribute=Value definitions each separated by a blank space. To list the user attributes in stanza format, use the -f flag. To list the information as colon-separated records, use the -c flag.

The following examples shows the use of the `lsuser` command with various flags.

- To display the user ID and group-related information for the root account in stanza form, enter:

```
# lsuser -f -a id pgrp home root
root:
        id=0
        pgrp=system
        home=/
```

- To display the user `ID`, `groups`, and `home` directory of `smith` in colon format, enter:

```
lsuser -c -a id home groups smith
```

- To display all the attributes of user smith in the default format, enter:

```
lsuser smith
```

  All the attribute information appears with each attribute separated by a blank space.

- To display all the attributes of all the users, enter:

```
lsuser ALL
```

  All the attribute information appears with each attribute separated by a blank space.

  Alternatively, you can use SMIT:

  a. Executing `smitty lsuser`, which will prompt you to a menu as shown in Figure 119.

  b. Type smith for the field User NAME and press the **Enter** key. This will display a screen as shown in Figure 120**.**

  c. When SMIT returns an OK prompt, press the **F10** key to return to the command prompt.

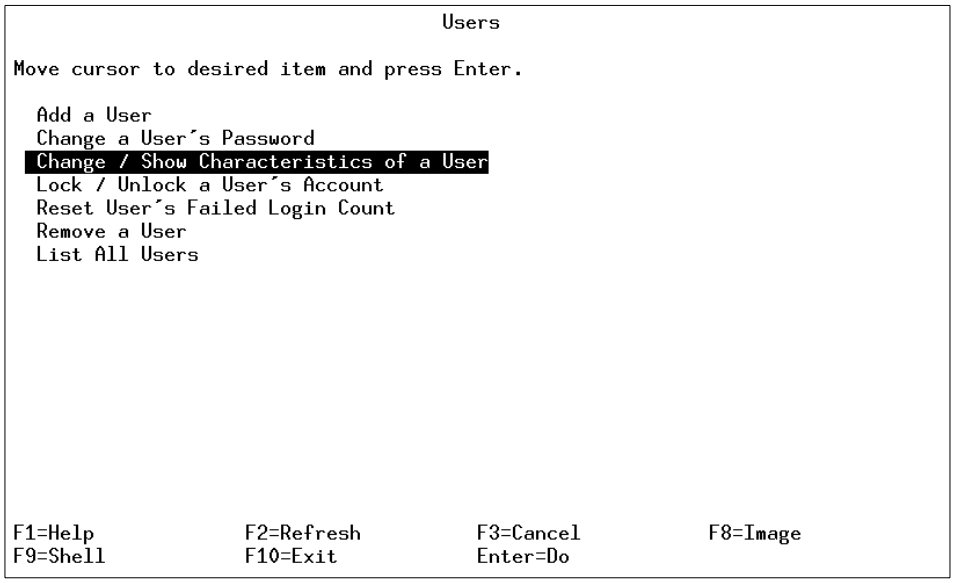

Figure 119. smitty users Command

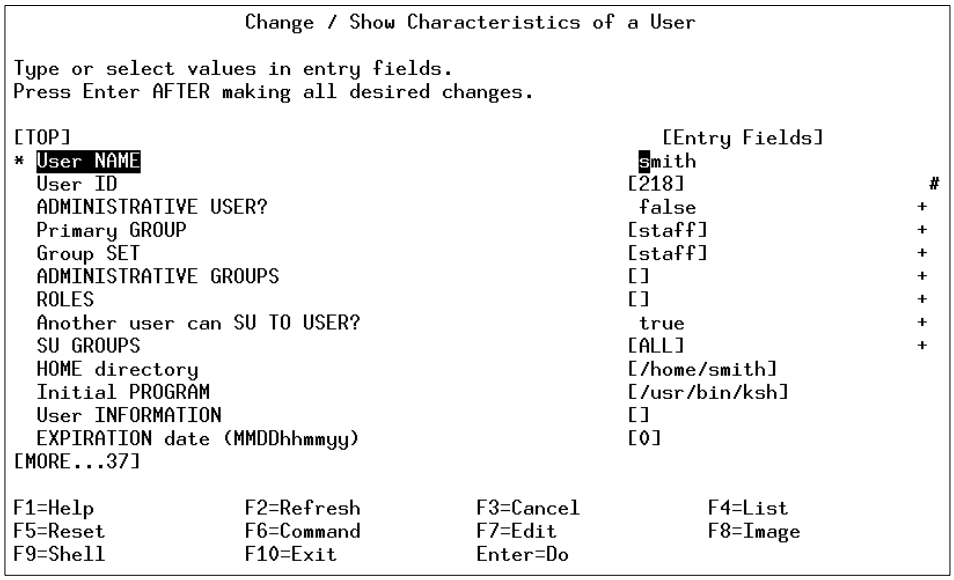

Figure 120. Listing User Characteristics

13.4.5 Removing a User Account

The `rmuser` command removes the user account identified by the Name parameter. This command removes a user's attributes without removing the user's home directory and files. The user name must already exist as a string of eight bytes or less. If the -p flag is specified, the `rmuser` command also removes passwords and other user authentication information from the /etc/security/passwd file.

Only the root user can remove administrative users.

- The following example shows the use of the `rmuser` command to remove a user account `smith` and its attributes from the local system.

  ```
  rmuser smith
  ```

- To remove the user smith account and all its attributes, including passwords and other user authentication information in the /etc/security/passwd file, use the following command:

  ```
  rmuser -p smith
  ```

  Alternatively, you can go through the SMIT hierarchy by:

  a. Executing `smitty rmuser` will prompt you to a menu as shown in Figure 121.

  b. Type `smith` for the field `User NAME`.

  c. Press the **Enter** key.

  d. When SMIT returns an OK prompt, Press the **F10** key to return to the command prompt.

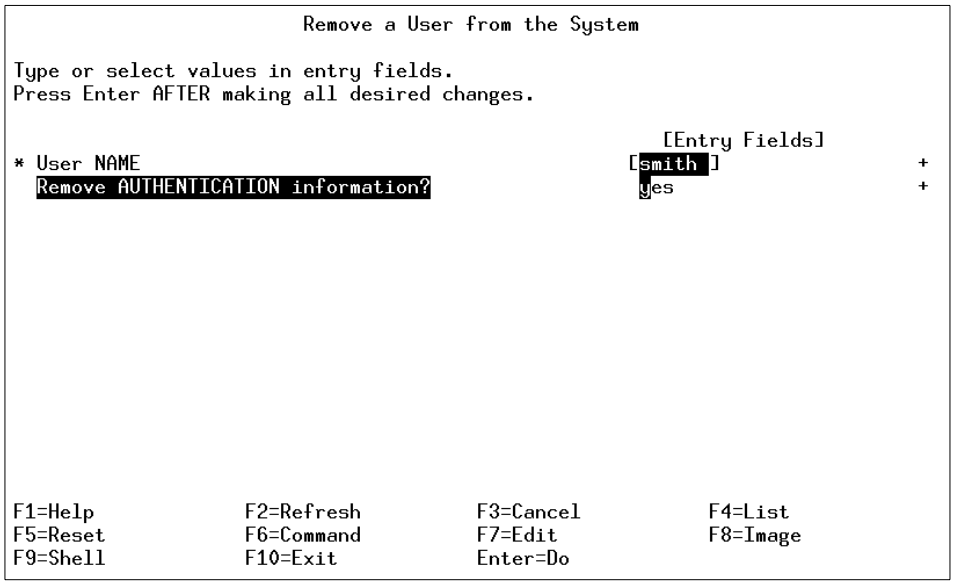

Figure 121. Removing a User

13.4.6 Changing Security Attributes of User

The `chsec` command changes the attributes stored in the security configuration stanza files. The following security configuration stanza files have attributes that you can specify with the Attribute = Value parameter.

- /etc/security/environ
- /etc/security/group
- /etc/security/lastlog
- /etc/security/limits
- /etc/security/login.cfg
- /usr/lib/security/mkuser.default
- /etc/security/passwd
- /etc/security/portlog
- /etc/security/user

When modifying attributes in the /etc/security/environ, /etc/security/lastlog, /etc/security/limits, /etc/security/passwd, and /etc/security/user files, the stanza name specified by the Stanza parameter must either be a valid user name or default.

When modifying attributes in the /etc/security/group file, the stanza name specified by the Stanza parameter must either be a valid group name or default.

When modifying attributes in the /usr/lib/security/mkuser.default file, the Stanza parameter must be either admin or user.

When modifying attributes in the /etc/security/portlog file, the Stanza parameter must be a valid port name. When modifying attributes in the /etc/security/login.cfg file, the Stanza parameter must either be a valid port name, a method name, or the usw attribute.

When modifying attributes in the /etc/security/login.cfg or /etc/security/portlog files in a stanza that does not already exist, the stanza is automatically created by the `chsec` command.

Note

You cannot modify the password attribute of the /etc/security/passwd file using the `chsec` command. Instead, use the `passwd` command.

The following examples show the usage of `chsec` command to change security stanzas in various files.

- To change the `/dev/tty0` port to automatically lock if five unsuccessful login attempts occur within 60 seconds, enter:

```
chsec -f /etc/security/login.cfg -s /dev/tty0 -a logindisable=5 -a
logininterval=60
```

- To unlock the `/dev/tty0` port after it has been locked by the system, enter:

```
chsec -f /etc/security/portlog -s /dev/tty0 -a locktime=0
```

- To allow logins from 8:00 a.m. until 5:00 p.m. for all users, enter:

```
chsec -f /etc/security/user -s default -a logintimes=:0800-1700
```

- To change the CPU time limit of user `smith` to one hour (3600 seconds), enter:

```
chsec -f /etc/security/limits -s smith -a cpu=3600
```

13.4.7 Displaying Currently Logged Users

The `who` command displays information about all users currently on the local system. The following information is displayed: Login name, tty, and the date and time of login. Entering `who am i` or `who am I` displays your login name, tty, and the date and time you logged in. If the user is logged in from a remote machine, then the host name of that machine is displayed as well. The `who` command can also display the elapsed time since line activity occurred, the

process ID of the command interpreter (shell), logins, logoffs, restarts, and changes to the system clock, as well as other processes generated by the initialization process.

Note

The /etc/utmp file contains a record of users logged into the system. The command `who -a` processes the /etc/utmp file, and if this file is corrupted or missing, no output is generated from the `who` command.

The following examples show the usage of the `who` command with various flags.

- The following example shows the command to display information about all the users who are logged on to the system.

```
# who
root        pts/0       Nov 17 10:20    (sv1166a.itsc.aus)
root        pts/2       Nov 23 10:45    (sv1121c.itsc.aus)
root        pts/3       Nov 23 10:48    (sv1121c)
```

- The following example shows the command to display your user name.

```
# who am I
root        pts/3       Nov 23 10:48    (sv1121c)
```

- The following shows how to display the run-level of the local system.

```
# who -r
   .        run-level 2 Nov 17 10:19      2    0    S
```

- To display any active process that was spawned by init, execute the following command.

```
# who -p
rc               .       Nov 17 10:19    4:12      2896 id=rc
fbcheck          .       Nov 17 10:19    4:12      2898 id=fbcheck
srcmstr          .       Nov 17 10:19    4:12      2900 id=srcmstr
rctcpip          .       Nov 17 10:19    4:12      4648 id=rctcpip
rcnfs            .       Nov 17 10:19    4:12      4650 id=rcnfs
cron             .       Nov 17 10:19    4:12      4652 id=cron
piobe            .       Nov 17 10:19    4:12      4984 id=piobe
qdaemon          .       Nov 17 10:19    4:12      4986 id=qdaemon
writesrv         .       Nov 17 10:19    4:12      4988 id=writesr
uprintfd         .       Nov 17 10:19    4:12      4990 id=uprintf
pmd              .       Nov 17 10:19    4:12      8772 id=pmd
dt               .       Nov 17 10:19    4:12      9034 id=dt
```

13.4.8 Changing User Login Shell

The chsh command changes a user's login shell attribute. The shell attribute defines the initial program that runs after a user logs in to the system. This attribute is specified in the /etc/passwd file. By default, the chsh command changes the login shell for the user who gives the command.

The chsh command is interactive. When you run the chsh command, the system displays a list of the available shells and the current value of the shell attribute, as shown in Figure 122. In addition to the default shells (/usr/bin/ksh, /usr/bin/sh, /usr/bin/bsh, /usr/bin/csh) your system manager may have defined more. Then, the system prompts you to change the shell. You must enter the full path name of an available shell.

If you have execute permission for the chuser command, you can change the login shell for another user.

```
# chsh
 Current available shells:
                /bin/sh
                /bin/bsh
                /bin/csh
                /bin/ksh
                /bin/tsh
                /usr/bin/sh
                /usr/bin/bsh
                /usr/bin/csh
                /usr/bin/ksh
                /usr/bin/tsh
                /usr/sbin/sliplogin
 root's current login shell:
                /bin/ksh
 Change (yes) or (no)? > yes
 To?>/bin/csh
# 
```

Figure 122. chsh Command

13.4.9 Changing the Shell Prompt

The shell uses the following three prompt variables.

PS1 Prompt used as the normal system prompt.

PS2 Prompt used when the shell expects more input.

PS3 Prompt used when you have root authority.

You can change any of your prompt characters by changing the value of its shell variable. The changes to your prompts last until you log off. To make your changes permanent, place them in your .env file.

The following command shows how to display the current value of the PS1 variable.

```
# echo "prompt is $PS1":
prompt is $
```

The following example shows the command to change the prompt to `Ready>`:

```
export PS1="Ready> "
```

The following example shows the command to change the continuation prompt to `Enter more->`:

```
export PS2="Enter more->"
```

The following example shows the command to change the root prompt to `Root->`:

```
export PS3="Root-> "
```

13.4.10 Starting AIX Common Desktop Environment

If the AIX Common Desktop Environment is not set up to start automatically on a locally attached graphics display, you can use the following command to start the desktop from an AIX command line.

```
xinit /usr/dt/bin/Xsession
```

Using the `xinit` command starts the desktop without bringing up the whole desktop environment. You will bypass the login screen when you start the desktop, and when you exit, you will return to a command line rather than an AIX Common Desktop Environment login screen. You will, however, use the same desktop applications you would use had you started the desktop from the welcome screen.

You can set up the system so that the AIX Common Desktop Environment comes up automatically when you start the system, or you can start AIX Common Desktop Environment manually. You must log in as root to perform each of these tasks.

13.4.10.1 Enabling and Disabling Desktop Autostart

To enable the desktop autostart, use `smit dtconfig` or `dtconfig -e`.

To disable the desktop autostart, use `smit dtconfig` or `dtconfig -d`.

13.4.10.2 Starting AIX Common Desktop Environment Manually.

Use the following command to start the AIX Common Desktop Environment at the command line.

```
/usr/dt/bin/dtlogin -daemon
```

A Desktop Login screen will display. When you log in, you will start a desktop session.

13.4.10.3 Stopping AIX Common Desktop Environment Manually.

When you manually stop the login manager, all X servers and desktop sessions that the login manager started are stopped.

1. Open a terminal emulator window and log in as root.
2. Obtain the process ID of the Login Manager by entering the following:

   ```
   cat /var/dt/Xpid
   ```

3. Stop the Login Manager by entering:

   ```
   kill -term process_id
   ```

13.5 Error Messages

The following section summarizes a few of the Error Messages for Component ID 3004 and their possible causes. Please refer *AIX Version 4.3 Messages Guide and Reference,* SC23-4129, for further details.

3004-004 `You must "exec" login from the lowest login shell`. You attempted to log off the system while processes are still running in another shell.

3004-007 `You entered an invalid login name or password`. You tried to log in to a system that does not recognize your login or password.

3004-008 `Failed setting credentials`. Login failed.

3004-009 `Failed running login shell`. You tried to log in to a system that has a damaged login shell. The login shell does not exist.

3004-030 `You logged in using all uppercase characters`. You attempted to log in with Caps Lock on.

3004-031 `Password read timed out--possible noise on port`. You logged in but did not enter your password within a specified amount of time. Your password was not validated within a specified amount of time due to a failed network connection.

3004-302 `Your account has expired. Please see the system administrator.` Your password has expired.

3004-312 `All available login sessions are in use.` You tried to log in to a system that had all present sessions in use.

3004-687 `User does not exist`. You specified an invalid user name with the `lsuser` command, the `chuser` command, the `rmuser` command, or the `passwd` command.

13.6 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. A user is able to get a login prompt for the server but gets a failed login error message when trying to login with an ID. Which of the following is the most likely cause of this problem?

   A. The hard drive is bad.

   B. The /home filesystem is full.

   C. The server is low on paging space.

   D. The user has entered an invalid ID or password.

2. Which of the following files contains uid, home directory, and shell information?

   A. /etc/passwd

   B. /etc/security/user

   C. /etc/security/environ

   D. /etc/security/passwd

3. A customer has cloned a machine using `mksysb`. The source machine contained a graphics adaptor and display and was running Xwindows. The target machine has an IBM 3151 terminal and no graphics capability. The customer states that they are seeing the following message repeatedly scroll across the login screen.

```
******************************************************
*  Starting Desktop Login on display :0÷
*
* Wait for the Desktop Login screen before loggin in.
*
******************************************************
```

To prevent this message from appearing, which of the following actions should be performed?

A. Run the `cdecfg -disable` command.

B. Run the `startx -no` command and reboot.

C. Run the `dtconfig -d` command and reboot.

D. Remove the X=start line from the /etc/security/login.cfg file and reboot.

4. After completing the installation of the Base Operating System on one of the servers, the system administrator would like for all users who Telnet into this machine to see a specific message each time they successfully log in. Which file should be edited to provide this message?

   A. /etc/motd

   B. /etc/profile

   C. /etc/environment

   D. /etc/security/login.cfg

5. A marketing manager would like her shell prompt to reflect the directory she is in so that if she needs to remove a file, she will be sure to be in the proper directory. Which of the following environment variables can be set to accomplish this?

   A. PS1

   B. PATH

   C. DISPLAY

   D. LOCPATH

13.6.1 Answers

The following are the answers to the previous questions:

1. D
2. A
3. C
4. A
5. A

13.7 Exercises

Provided here are some exercises you may wish to perform:

1. Add a new user account (james) and try to log in into the new account. Can you log in without creating a password for this account?
2. Create a password for a newly created user account (james).
3. You want all the users to get the following message when they log in:

   ```
   ********************************************************************************

   Please assemble in the meeting room at 13:00 hrs on Nov.20,1998

   ********************************************************************************
   ```

   Which file needs to be edited to contain this message so that the message is displayed when a user logs in?
4. Move the file /etc/utmp to /etc/wtmp.org. Run the `who` command. What is the output?
5. Change the password of a user account who does not remember his old password?
6. How can you disable the desktop autostart?
7. Display the attributes of the user account.
8. Permanently change your shell prompt to display the current directory.

Chapter 14. Printing

The following defines terms commonly used when discussing UNIX printing.

- Print Job

  A print job is a unit of work to be run on a printer. A print job can consist of printing one or more files depending on how the print job is requested. The system assigns a unique job number to each job it runs.

- Queue

  The queue is where you direct a print job. It is a stanza in the /etc/qconfig file whose name is the name of the queue and points to the associated queue device.

- Queue Device

  The queue device is the stanza in the /etc/qconfig file that normally follows the local queue stanza. It specifies the /dev file (printer device) that should be used.

  Note

  There can be more than one queue device associated with a single queue.

- qdaemon

  The qdaemon is a process that runs in the background and controls the queues. It is generally started during IPL.

- Print Spooler

  The spooler is not specifically a print job spooler. Instead, it provides a generic spooling function that can be used for queuing various types of jobs including print jobs queued to a printer.

  The spooler does not normally know what type of job it is queuing. When the system administrator defines a spooler queue, the purpose of the queue is defined by the spooler backend program that is specified for the queue. For example, if the spooler backend program is the `piobe` command (the printer I/O backend), the queue is a print queue. Likewise, if the spooler backend program is a compiler, the queue is for compile jobs. When the spooler's `qdaemon` command selects a job from a spooler queue, it runs the job by invoking the backend program specified by the system administrator when the queue was defined.

  The main spooler command is the `enq` command. Although you can invoke this command directly to queue a print job, three front-end commands are

defined for submitting a print job: The `lp`, `lpr`, and `qprt` commands. A print request issued by one of these commands is first passed to the `enq` command, which then places the information about the file in the queue for the qdaemon to process.

- Real Printer

  A real printer is the printer hardware attached to a serial or parallel port at a unique hardware device address. The printer device driver in the kernel communicates with the printer hardware and provides an interface between the printer hardware and a virtual printer, but it is not aware of the concept of virtual printers. Real printers sometimes run out of paper.

- Local and Remote Printers

  When you attach a printer to a node or host, the printer is referred to as a local printer. A remote print system allows nodes that are not directly linked to a printer to have printer access.

  To use remote printing facilities, the individual nodes must be connected to a network using the Transmission Control Protocol/Internet Protocol (TCP/IP) and must support the required TCP/IP applications.

- Printer Backend

  The printer backend is a collection of programs called by the spooler's `qdaemon` command to manage a print job that is queued for printing. The printer backend performs the following functions:

  - Receives from the `qdaemon` command a list of one or more files to be printed
  - Uses printer and formatting attribute values from the database overridden by flags entered on the command line
  - Initializes the printer before printing a file
  - Runs filters as necessary to convert the print data stream to a format supported by the printer
  - Provides filters for simple formatting of ASCII documents
  - Provides support for printing national language characters
  - Passes the filtered print data stream to the printer device driver
  - Generates header and trailer pages
  - Generates multiple copies
  - Reports paper out, intervention required, and printer error conditions
  - Reports problems detected by the filters

- Cleans up after a print job is canceled
- Provides a print environment that a system administrator can customize to address specific printing needs

Table 40 provides list of commands that can perform the same function.

Table 40. Print Commands and Their Equivalents

Submit print jobs	Status print jobs	Cancel print jobs
enq	enq -A	enq -x
qprt	qchk	qcan
lp	lpstat	lprm
lpr	lpq	

14.1 Creating a New Print Queue

The best way for you to create a new print queue is by using the SMIT interface. Here are the steps you need to follow.

Enter the following command:

```
smitty
```

Go to the System Management menu where you will select **Print Spooling** as shown in Figure 123 and press **Enter**.

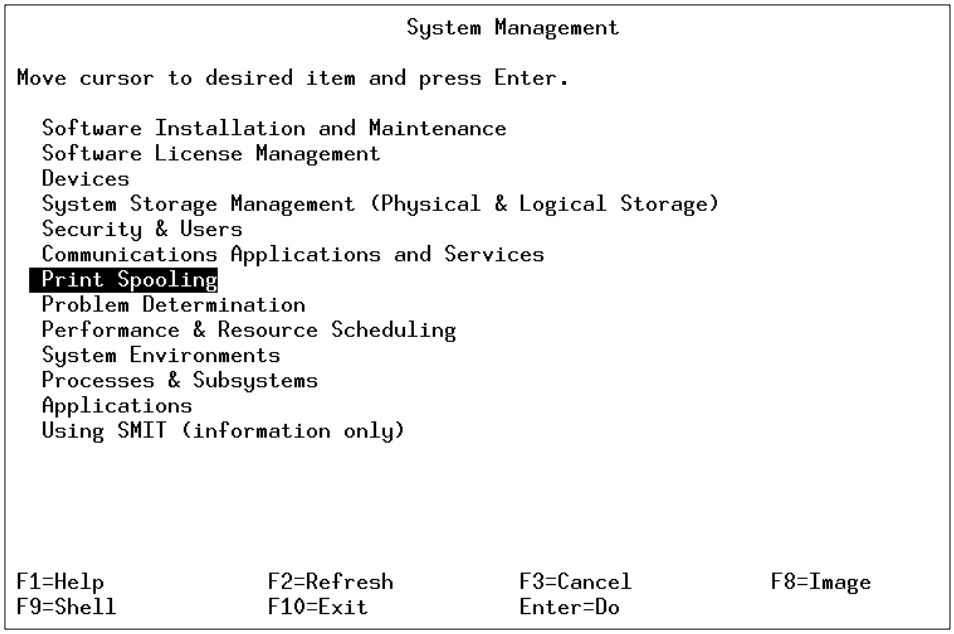

Figure 123. System Management Menu Window - Print Spooling Option

Go into the Print Spooling menu where you will select **Add a Print Queue** as shown in Figure 124 and press **Enter**.

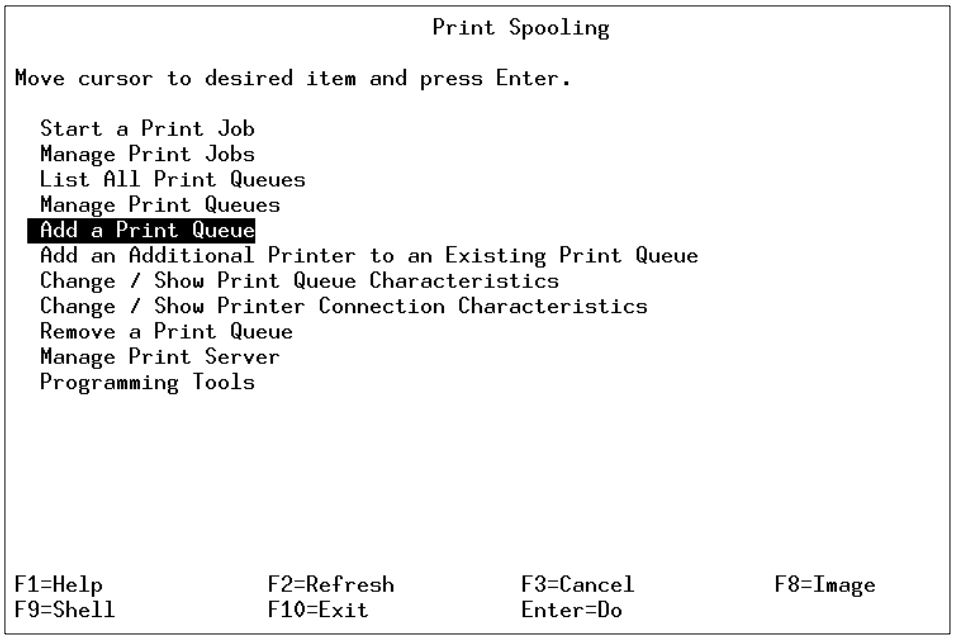

Figure 124. Print Spooling Menu Window - Add a Print Queue

Figure 125 shows the Print Spooling menu in which an Add a Print Queue sub menu will appear. Select what the printer is connected to, in this case local, and press **Enter**.

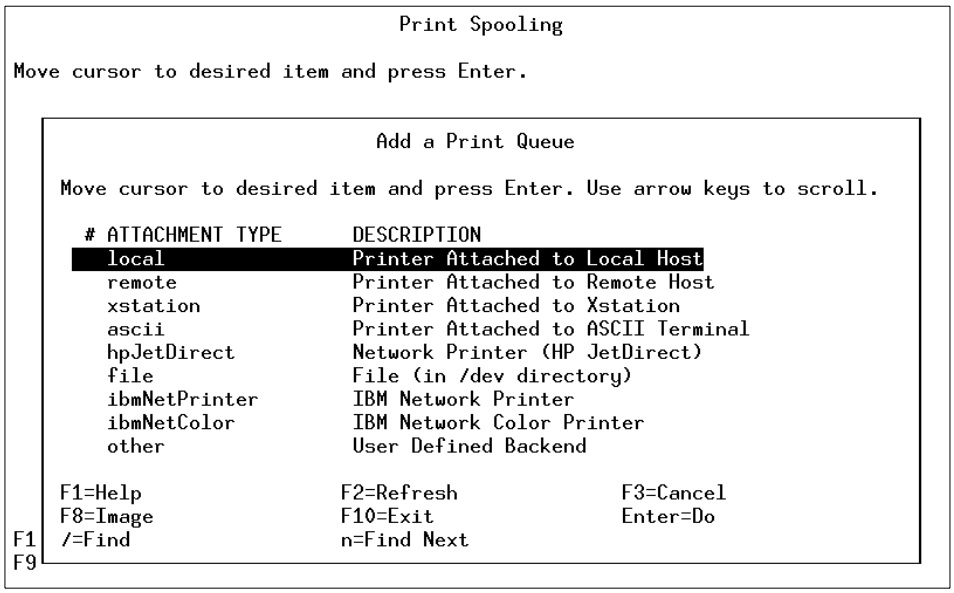

Figure 125. Add a Print Queue Menu Window - Print Queue Selection

Once you selected where the printer is connected to, select what kind of printer it is and press **Enter**. In Figure 126, Other (select this if your printer type is not listed above) has been selected.

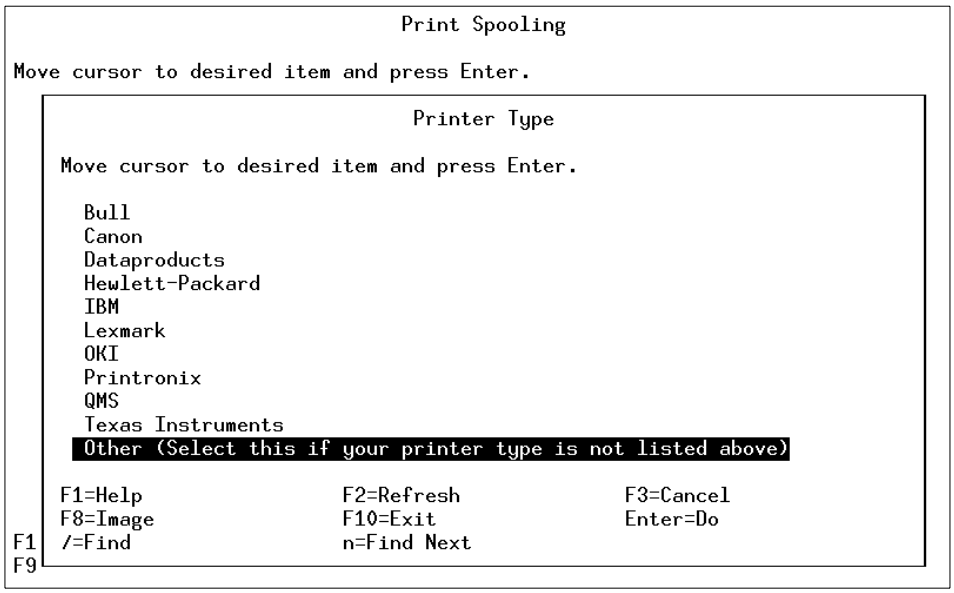

Figure 126. Print Spooling Menu Window - Print Type Selection

Figure 127 shows where the Printer Type is selected. Here, select **generic Generic Printer** and press **Enter**.

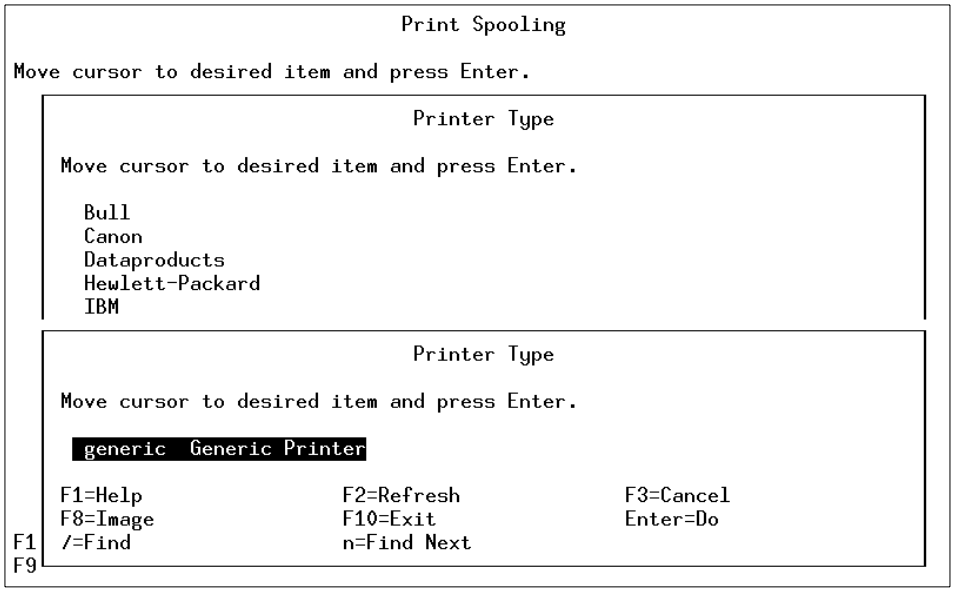

Figure 127. Print Spooling Menu - Print Type Selection

You now need to select the Printer Interface. As shown in Figure 128, select **parallel** as your choice and press **Enter**.

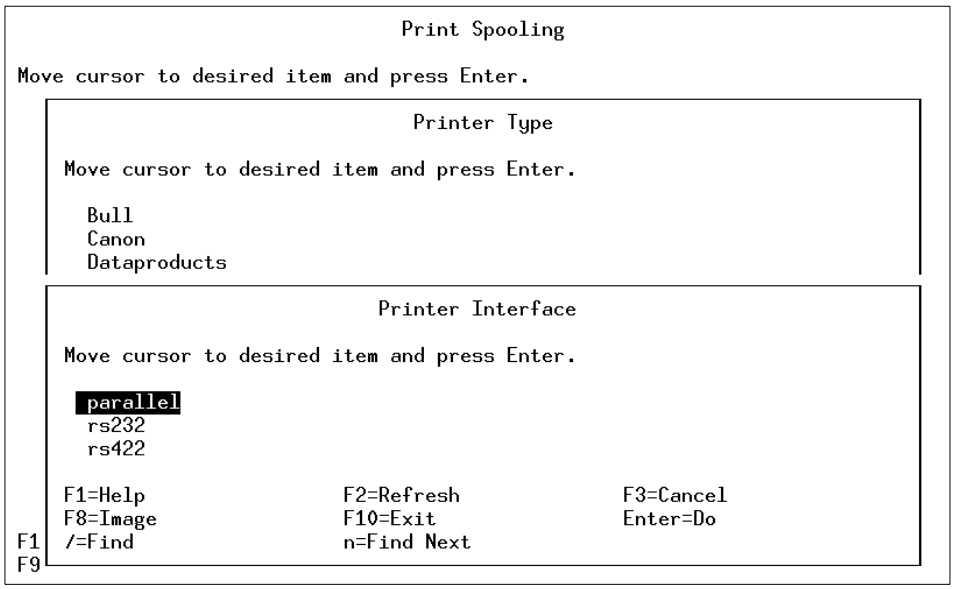

Figure 128. Print Spooling Menu - Print Interface Selection

Once your Printer Interface has been selected, you need to select the Parent Adapter (in Figure 129, select **ppa0 Available 01-D0 Standard I/O Parallel Port Adapter** as your choice) and press **Enter**.

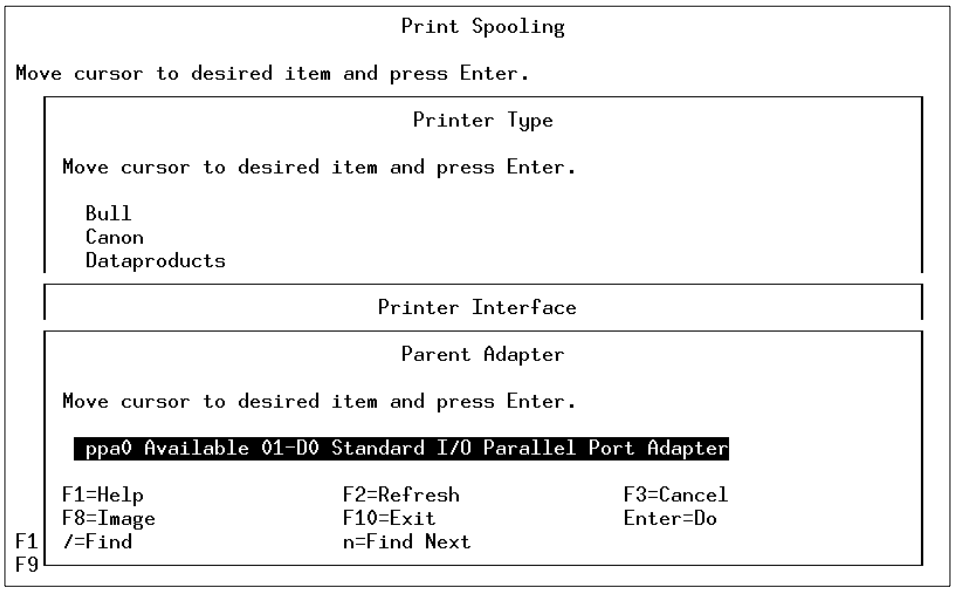

Figure 129. Print Spooling Menu - Parent Adapter

Once this process is complete, you will Add a Print Queue. As is shown in Figure 130. This is where you select what you want to call your printer. In this

case, the printer is called `lpforu`. You can change any of the characteristics of the printer if you need; however, this is normally not needed.

```
                                Add a Print Queue

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

                                                      [Entry Fields]
  Description                                         Generic Printer

  Names of NEW print queues to add
     ASCII                                            [lpforu]
     GL Emulation                                     []
     PCL Emulation                                    []
     PostScript                                       []

  Printer connection characteristics
*    PORT number                                      [p]                    +
     Type of PARALLEL INTERFACE                       [standard]             +
     Printer TIME OUT period (seconds)                [60]                   +
     STATE to be configured at boot time               available             +


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

Figure 130. Add a Print Queue Menu - Print Characteristics

Once you have entered your characteristics, the COMMAND STATUS menu will appear informing you of the success of your action as shown in Figure 131.

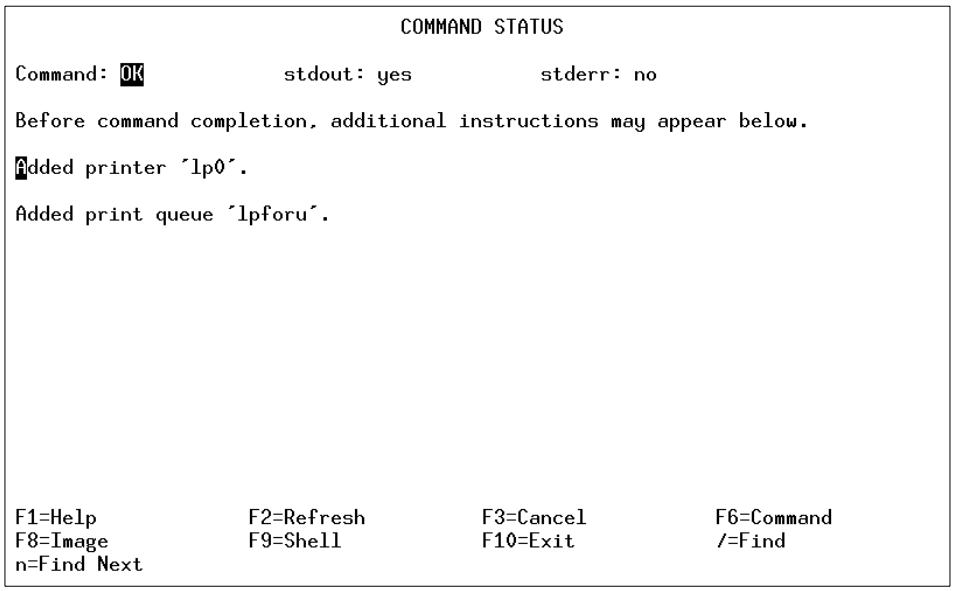

Figure 131. New Print Queue Command Status

Once complete, press **F10** to exit.

You have now installed the print queue lpforu on the printer lp0.

14.2 The Print Configuration File

The file that holds the configuration for the printers that exist on the system is the /etc/qconfig file. It is the most important file in the spooler domain for these reasons:

- It contains the definition of every queue known to the spooler.
- A system administrator can read this file and discern the function of each queue.
- Although it is not recommended, this file can be edited to modify spooler queues without halting the spooler.

The /etc/qconfig file describes all of the queues defined in the AIX operating system. A queue is a named, ordered list of requests for a specific device. A device is something (either hardware or software) than can handle those requests one at a time. The queue provides serial access to the device. Each

queue must be serviced by at least one device; often it can be handled by more than one device.

The following is an example of the contents of the /etc/qconfig file.

```
* @(#)33        1.6  src/bos/usr/bin/que/qconfig.sh, cmdque, bos430, 9737A_430 2/4/94
10:45:05
/4/94 10:45:05
* IBM_PROLOG_BEGIN_TAG
..........
* IBM_PROLOG_END_TAG
*
* COMPONENT_NAME: cmdque configuration file for spooling
..........
* PRINTER QUEUEING SYSTEM CONFIGURATION
*
* This configuration file contains valid configurations for remote
* print queue rp0, local print queue lp0 and batch queue bsh.
* They may be deleted or changed as necessary.
*
* EXAMPLE of remote print queue configuration
* rp0:
*       host = hostname
*       s_statfilter = /usr/lib/lpd/aixshort
*       l_statfilter = /usr/lib/lpd/aixlong
*       rq = queuename
*       device = drp0
*
* drp0:
*       backend = /usr/lib/lpd/rembak
*
* EXAMPLE of local print queue configuration
*lp0:
*       discipline = fcfs
*       up = TRUE
*       device = dlp0
*
*dlp0:
*       backend = /usr/lib/lpd/piobe
*       file = FALSE
*       access = write
*       feed = never
*       header = never
*       trailer = never
*
* BATCH queue for running shell scripts
*
*bsh:
*       device = bshdev
*       discipline = fcfs
*bshdev:
*       backend = /usr/bin/bsh
lpforu:
device = lp0
lp0:
        file = /dev/lp0
        header = never
        trailer = never
        access = both
        backend = /usr/lib/lpd/piobe
```

The file /etc/qconfig is composed of text blocks referred to as stanzas. Each queue is represented by a pair of stanzas. The first stanza in a pair is referred to as the queue stanza; the second stanza in a pair is referred to as the device stanza. Stanzas are composed of parameters and parameter values that describe the queue's properties and functions.

14.3 Controlling the Print Queue

This section examines some of the commands that you would use with the print queue.

- The `lpstat` command displays information about the current status of the line printer.

  The lpstat command syntax is as follows:

  ```
  lpstat [ -aList ] [ -cList ] [ -d ] [ -oList ] [ -pList ] [ -r ] [ -s ]
  [ -t ] [ -uList ] [ -vList ] [ -W ]
  ```

  An example of the `lpstat` command without any flags is as follows:

  ```
  # lpstat
  Queue  Dev  Status  Job Files            User         PP% Blks Cp Rnk
  ------ ---- ------- --- ---------------- ------------ --- ---- -- ---
  lpforu lp0  READY
  ```

- The `qchk` command displays the current status information regarding specified print jobs, print queues, or users.

  The qchk command syntax is as follows:

  ```
  qchk [ -A ] [ -L | -W ] [ -P Printer ] [ -# JobNumber ] [ -q ] [ -u
  UserName ] [ -w Delay ]
  ```

  An example of the `qchk` command without any flags is as follows:

  ```
  # qchk
  Queue  Dev  Status  Job Files            User         PP% Blks Cp Rnk
  ------ ---- ------- --- ---------------- ------------ --- ---- -- ---
  lpforu lp0  READY
  ```

- The `lpq` command reports the status of the specified job or all jobs associated with the specified *UserName* and *JobNumber* variables.

  The lpq command syntax is as follows:

  ```
  lpq [ + [ Number ] ] [ -l | -W ] [-P Printer ] [JobNumber] [UserName]
  ```

  The following is an example of the `lpq` command without any flags.

  ```
  # lpq
  Queue  Dev  Status  Job Files            User         PP% Blks Cp Rnk
  ------ ---- ------- --- ---------------- ------------ --- ---- -- ---
  lpforu lp0  READY
  ```

- The `lpr` command uses a spooling daemon to print the named File parameter when facilities become available.

```
The lpr command syntax is as follows:
lpr [ -f ] [ -g ] [ -h ] [ -j ] [ -l ] [ -m ] [ -n ] [ -p ] [ -r ] [ -s
] [ -P Printer ] [ -# NumberCopies ] [ -C Class ] [ -J Job ] [ -T Title
] [ -i [ NumberColumns ] ] [ -w Width ] [ File ... ]
```

The following is an example of using the `lpr` command to print the file /etc/passwd.

```
# lpr /etc/passwd
# lpstat
Queue  Dev  Status   Job  Files            User       PP %  Blks Cp Rnk
------ ---- -------- ---  ---------------- -------- ---- -- ---- -- ---
lpforu lp0  RUNNING    3  /etc/passwd      root        1 100   1  1   1
```

14.3.1 Editing /etc/qconfig

The /etc/qconfig configuration file can be edited with your text editor of choice. There are unenforced rules concerning when you can and cannot edit /etc/qconfig without halting or corrupting the operation of the spooler. This is the topic of discussion in the next section.

14.3.2 Modifying /etc/qconfig While Jobs are Processing

The /etc/qconfig file should never be edited when jobs are processing. This is especially true when your system has a large number (greater than 25) of printers that are generally busy. When the qdaemon receives notification from `enq` that a new Job Description File (JDF) exists, the qdaemon examines the dates on both /etc/qconfig and /etc/qconfig.bin, the binary version of /etc/qconfig. If /etc/qconfig is younger than /etc/qconfig.bin, the qdaemon does not accept any new jobs including the one that caused it to examine the aforementioned files until all currently running jobs have finished processing. When the jobs have finished processing, the qdaemon creates a new version of /etc/qconfig.bin.

If you cause the qdaemon to go into this state while jobs are processing, it is possible for the spooler to hang.

14.4 Stopping the Print Queue

In the following scenario, you have a job printing on a print queue, but you need to stop the queue so that you can put more paper in the printer.

Check the print queue using the `lpstat` command as shown in the following example. The reason for the -v flag is so that you do not get a listing of all the printers. See Table 43 on page 357 for a list of `lpstat` command flags.

```
# lpstat -vlpforu
Queue  Dev  Status   Job  Files           User       PP %  Blks Cp Rnk
------ ---- -------- ---  --------------- -------- ---- -- ---- -- ---
lpforu lp0  RUNNING    3  /etc/passwd     root        1 100   1  1   1
```

Disable the print queue using the `enq` command as shown in the following example. See Table 41 on page 355 for a list of `enq` command flags.

```
# enq -D -P 'lpforu:lp0'
```

Checking the printer queue using the `qchk` command as shown in the following example. See Table 42 on page 356 for some qchk command flags.

```
# qchk -Plpforu
Queue  Dev  Status   Job  Files           User       PP %  Blks Cp Rnk
------ ---- -------- ---  --------------- -------- ---- -- ---- -- ---
lpforu lp0  DOWN       3  /etc/passwd     root        1 100   1  1   1
```

Table 41. Flags for the enq Command

Flag	Description
-D	Device DOWN. Turns off the device associated with the queue. The qdaemon process no longer send jobs to the device.
-U	Brings UP the device associated with a queue. The qdaemon process sends jobs to it again.
-P *Queue*	Specifies the queue to which the job is sent. A particular device on a queue can be specified by typing -P *Queue:Device*.

14.5 Starting the Print Queue

You have replaced the paper, and you now want to restart the print queue so that it will finish your print job. Here is how you would do this.

```
# lpstat -vlpforu
Queue  Dev  Status   Job  Files           User       PP %  Blks Cp Rnk
------ ---- -------- ---  --------------- -------- ---- -- ---- -- ---
lpforu lp0  DOWN       3  /etc/passwd     root        1 100   1  1   1
# enq -U -P 'lpforu:lp0'
# qchk -P lpforu
Queue  Dev  Status   Job  Files           User       PP %  Blks Cp Rnk
------ ---- -------- ---  --------------- -------- ---- -- ---- -- ---
lpforu lp0  RUNNING    3  /etc/passwd     root        1 100   1  1   1
```

Table 42. Flags for the qchk Command

Flag	Description
-# *JobNumber*	Requests the status of the job number specified by the *JobNumber* variable. The qchk command looks for *JobNumber* on the default queue when the *-#JobNumber* flag is used alone. To search for *JobNumber* on all queues, the *-#* flag must be used with the -A flag. The *-#* flag may also be used in conjunction with the -P *Queue* flag.
-A	Requests the status of all queues.
-P *Printer*	Requests the status of the printer specified by the *Printer* variable.
-u *UserName*	Requests the status of all print jobs sent by the user specified by the *UserName* variable.
-w *Delay*	Updates requested status information at intervals, in seconds, as specified by the *Delay* variable until all print jobs are finished.

14.6 Flushing a Print Job

You discovered that the first job you printed was the incorrect one. You printed the correct one but now want to delete the first job. This is how it would be done.

Check the status of the print queue.

```
# lpstat -vlpforu
Queue  Dev  Status   Job  Files            User       PP %  Blks Cp Rnk
------ ---- -------- ---  ---------------- -------- ---- -- ---- -- ---
lpforu lp0  RUNNING      3  /etc/passwd      root        1 100   1  1   1
```

Print the /etc/hosts file to the default printer.

```
# lpr -dlpforu /etc/hosts
```

Check the status of the print queue.

```
# lpstat -vlpforu
Queue  Dev  Status   Job  Files            User       PP %  Blks Cp Rnk
------ ---- -------- ---  ---------------- -------- ---- -- ---- -- ---
lpforu lp0  RUNNING    3  /etc/passwd      root        1 100   1  1   1
            QUEUED     4  /etc/hosts       root        1 100   2  1   2
```

Cancel the print job for /etc/passwd.

```
# qcan -Plpforu -x3
```

Check the print queue using the `qchk` command.

```
# qchk -P lpforu
Queue  Dev  Status   Job  Files           User       PP %  Blks Cp Rnk
------ ---- -------- ---  --------------- -------- ---- -- ---- -- ---
lpforu lp0  RUNNING    4  /etc/hosts      root        1 100   2  1   2
```

Another option for cancelling a print job is to use the `cancel` command with the Job Number. For example:

```
cancel 3
```

This will do the same as `qcan -Plpforu -x3`.

14.7 How to Check the Print Spooler

There are various commands to check a print spooler. This section covers the `lpstat` command and some of the flags you can use. The `enq` command has a similar function.

In Table 43 are some of the flags used by the `lpstat` command and, where available, an equivalent `enq` command.

Table 43. Flags for the lpstat Command and enq Command Equivalents

Flag	**enq Equivalent**	Description
-a*List*	`enq -q -P`*`Queue1`*	Provides status and job information on queues.
-d	`enq -q`	Displays the status information for the system default destination for the `lp` command.
-o*List*		Displays the status of print requests or print queues.
-p*List*		Displays the status of printers.
-r	`enq -A`	Provides status and job information on queues.
-s	`enq -A`	Displays a status summary including a list of printers and their associated devices.
-t	`enq -AL`	Displays all status information including a list of printers and their associated devices.

Flag	`enq` Equivalent	Description
-u*List*	`enq -u`	Prints the status of all print requests for users specified in List. List is a list of login names.
-vList		Prints the status of printers. The List variable is a list of printer names.

The following is an example of using the `lpstat` command with different flag settings to get the status of the print queue lpforu:

The output for the `lpstat -t` command is the same as the output for the `lpstat -u` and `lpstat -p` commands except that it gives the queue file as well as the time stamp for the file in the queue.

```
# lpstat -plpforu
Queue   Dev Status    Job Files              User         PP %   Blks  Cp Rnk
------ --- --------- --- ------------------ ---------- ---- -- ----- --- --
lpforu  lp0 RUNNING 2 /etc/hosts         root                  2   1   1
# lpstat -u"root"
Queue   Dev Status    Job Files              User         PP %   Blks  Cp Rnk
------- --- --------- --- ------------------ ---------- ---- -- ----- --- -
lpforu  lp0   RUNNING 2 /etc/hosts         root                  2   1   1
```

14.8 Setting the Time Out on a Printer

Setting the time out on a printer specifies the amount of time, in seconds, the system waits for an operation to complete on a printer. The value must be greater than zero (0). The default value is calculated based on the device you select.

This option would be used in the following scenarios:

- A large network with many users utilizing the printers.
- A network with printers a long distance from the server or at another location.

Enter the following command:

```
smitty
```

Once run, select the **Print Spooling** option in the System Management menu as in Figure 132.

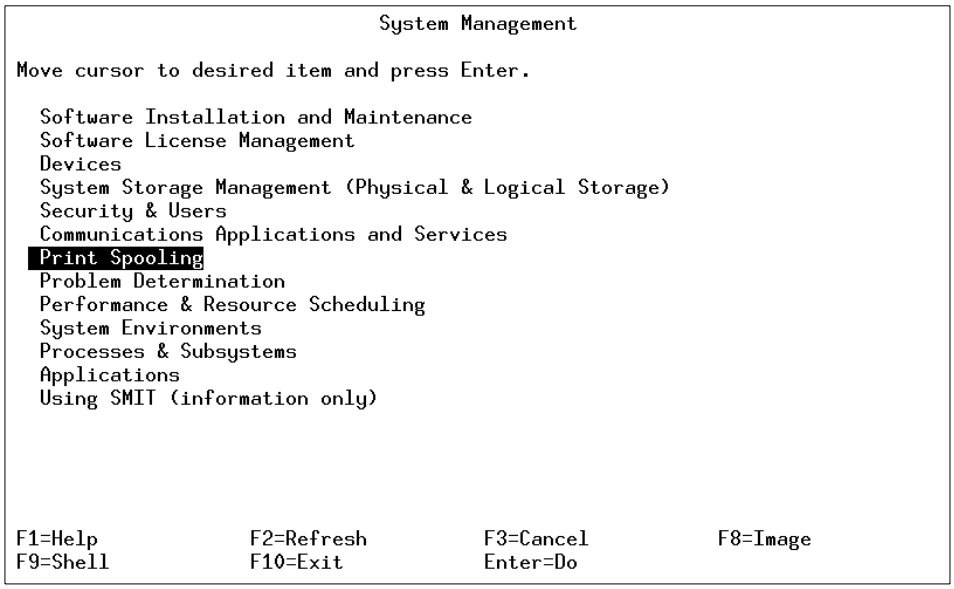

Figure 132. System Management Menu

In the Print spooling menu, select **Change / Show Printer Connection Characteristics** as in Figure 133.

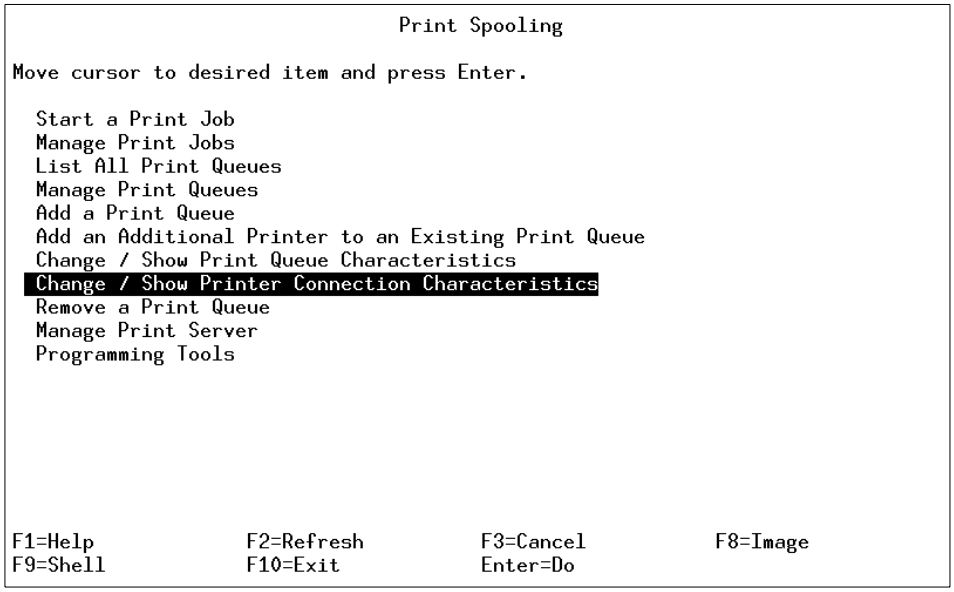

Figure 133. Print Spooling Menu

In the Change/Show Printer Connection Characteristics sub window, select where the printer is connected to. In Figure 134, **local** is used.

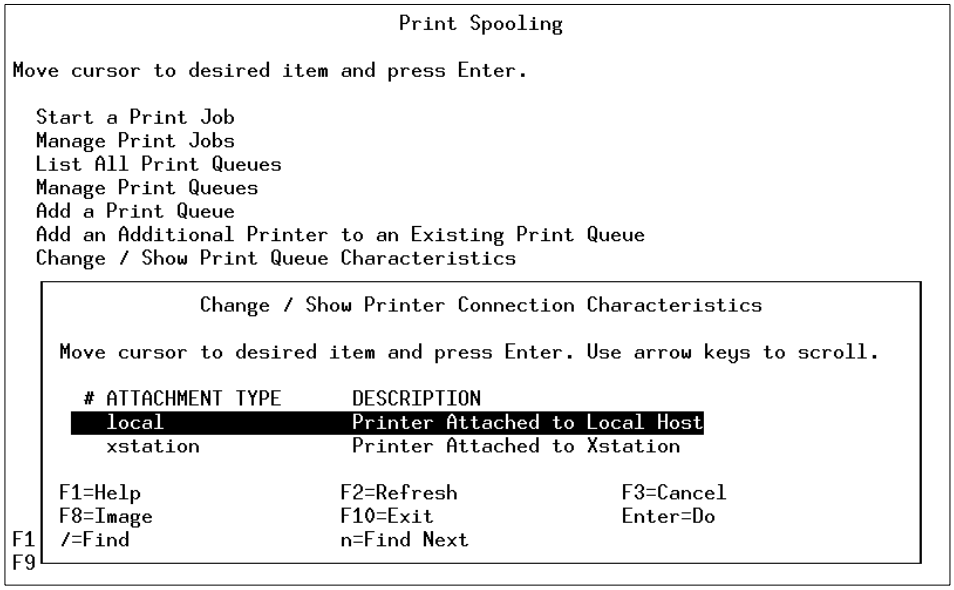

Figure 134. Print Menu - Change/Show Print Connection Characteristics

Shown in Figure 135 is the Local Printers selection sub-menu. Here you select **lp0 Available 01-d0-00-00 Other parallel printer**, and press **Enter**.

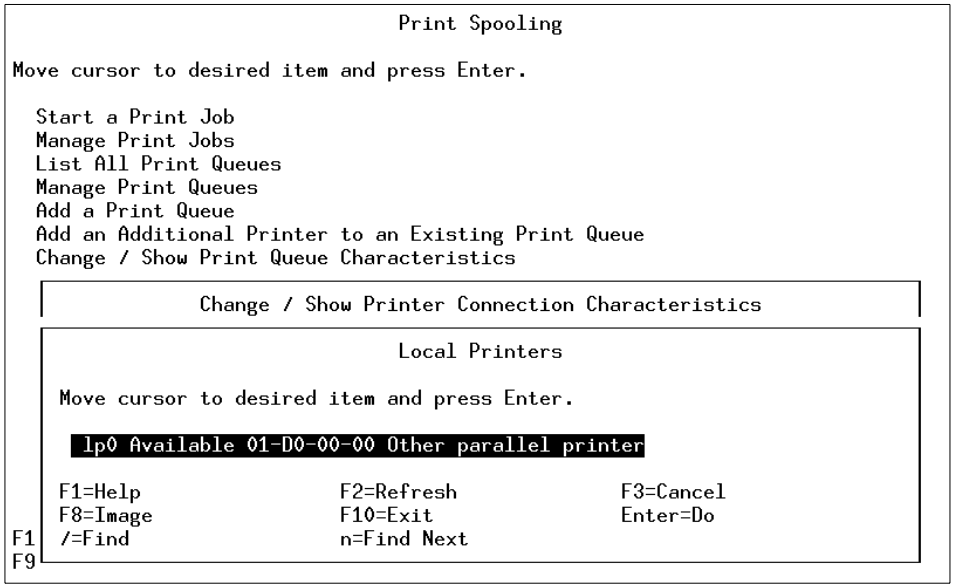

Figure 135. Print Spooling Menu - Local Printers

Once everything is selected, you will go to the Change/Show Printer Connection Characteristics menu as displayed in Figure 136. Here you select the **Printer TIME OUT period (seconds)** and change it. In this case, to 60 seconds.

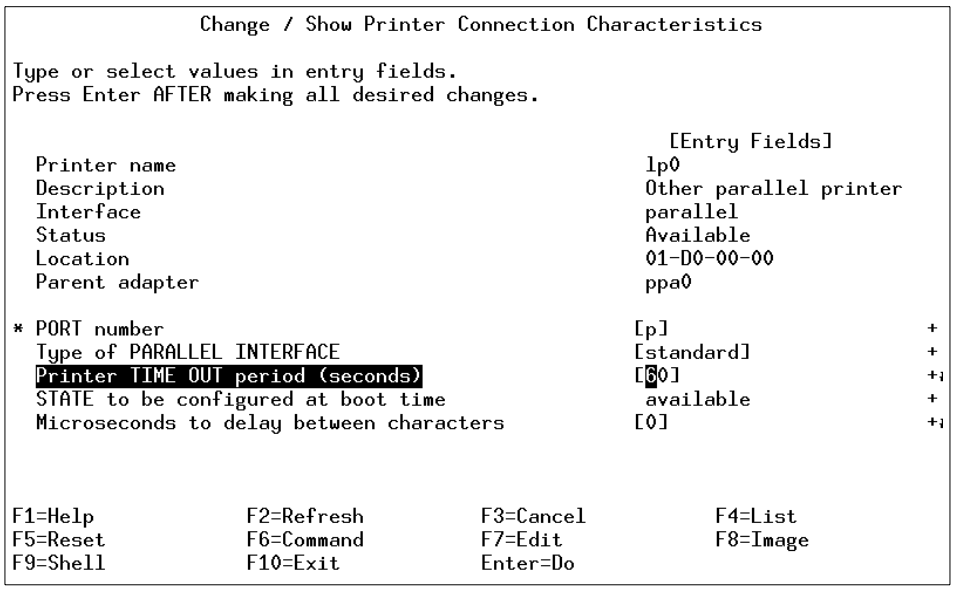

Figure 136. Change/Show Print Connection Characteristics

Once the command has completed, you will get the COMMAND STAUS menu, as displayed in Figure 137, which shows the status of command completion.

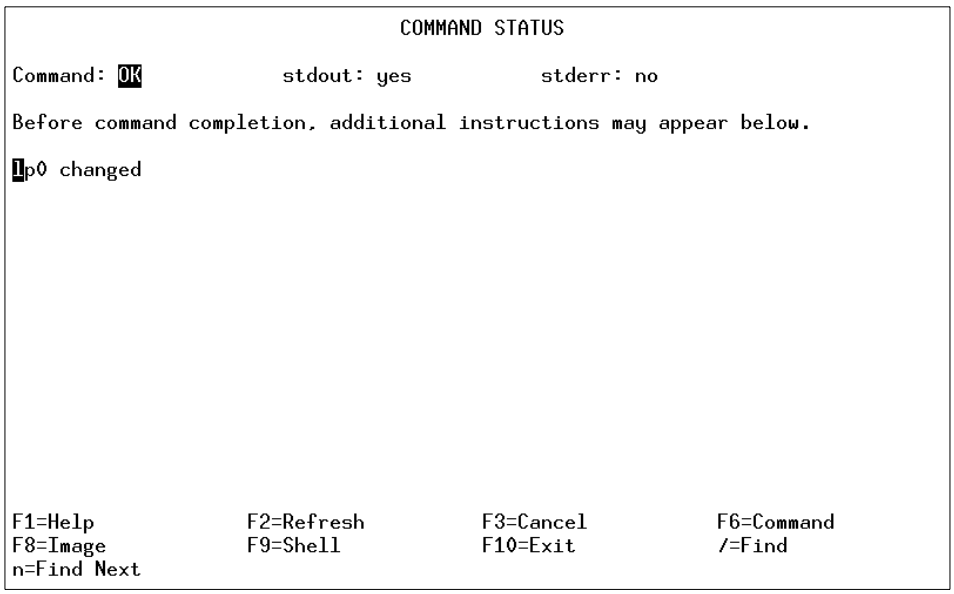

Figure 137. Command Status Screen - Command Completed Successfully

14.9 Basic Printer Diagnostics Checklist

In this section are some troubleshooting tips. This is not a comprehensive list, but it will assist you with some of the more common problems you with resolving some of the more common problems you may encounter.

- Verify that the qdaemon is running. Make sure there are no forked processes running from the qdaemon.
- Make sure the system date is correct. The qdaemon automatically rebuilds the /etc/qconfig.bin file when the qconfig file changes. If the date on the qconfig file is earlier than the date on the /etc/qconfig.bin file, the qconfig file is not digested even if it was just modified. Use the `enq -Y` command to redigest the qconfig file.
- If the dates on the /etc/qconfig.bin file and the /etc/qconfig file are correct, and changes to the qconfig file are correct, the /etc/qconfig file may be no longer linked to the /usr/lpd/qconfig file.

- Check that the /tmp directory is not full. The /tmp directory may be full if you receive a message, such as *No Virtual Printers Defined*, or if your are unable to print from InfoExplorer.
- If only the root user can print, check the permissions of the /tmp directory. Also, check the permissions of the print commands being used (including `enq`).
- Check for obsolete queue names in the /var/spool/lpd/qdir file. A problem with the installation of a new /etc/qconfig file, occurs when a queue is removed from the new /etc/qconfig file and a print request is made using the obsolete queue name. The qdaemon logs an error message. You must determine if the message refers to an old queue. If so, the problem will persist until you remove the obsolete queue entries from the /var/spool/lpd/qdir file.
- If operator-attention messages requested by remote print commands are not being received, make sure the socket is connected, and the host name can be pinged.

14.10 Quiz

The following questions will help verify your knowledge on the subject of printer administration.

1. To list the print job 120 on printer lineprinter, which command would you use?

   A. `qchk lineprinter`

   B. `qcan 120`

   C. `ps lineprinter`

   D. `lsdev lineprinter | grep 120`

2. To print the file /etc/host to the printer lineprinter, which command would you use?

   A. `lpr /etc/hosts -P lineprinter`

   B. `lpstat lineprinter`

   C. `lprm /etc/hosts -P lineprinter`

   D. `print /etc/hosts`

14.10.1 Answers

The following are the answers to the previous questions:

1. A
2. A

14.11 Exercises

Provided here are some exercises you may wish to perform:

1. Create a new print queue called 3k120.
2. Explain the /etc/qconfig file.
3. Start the print queue 3k120.
4. Stop the print queue 3k120.
5. Change the Time Out on the printer to twice its original Time Out.
6. Check the print queue using four different print commands.
7. Flush a print job.

Chapter 15. Sendmail and Email

The mail facility provides a method for exchanging electronic mail between the users on the same system or on multiple systems connected by a network. This chapter discusses mail configuration tasks, mail configuration files, mail aliases, and mail logs.

15.1 Overview of Mail System

The mail system is an internetwork mail delivery facility that consists of a user interface, a message routing program, and a message delivery program (or mailer).

A mail user interface enables users to create, send messages to, and receive messages from other users. The mail system provides two user interfaces, mail and mhmail. The `mail` command is the standard mail user interface available on all UNIX systems. The `mhmail` command is the Message Handler (MH) user interface, an enhanced mail user interface designed for experienced users.

A message routing program routes messages to their destinations. The mail system's message routing program is the `sendmail` command (a daemon). Depending on the type of route to the destination, the `sendmail` command uses different mailers to deliver messages as shown in Figure 138.

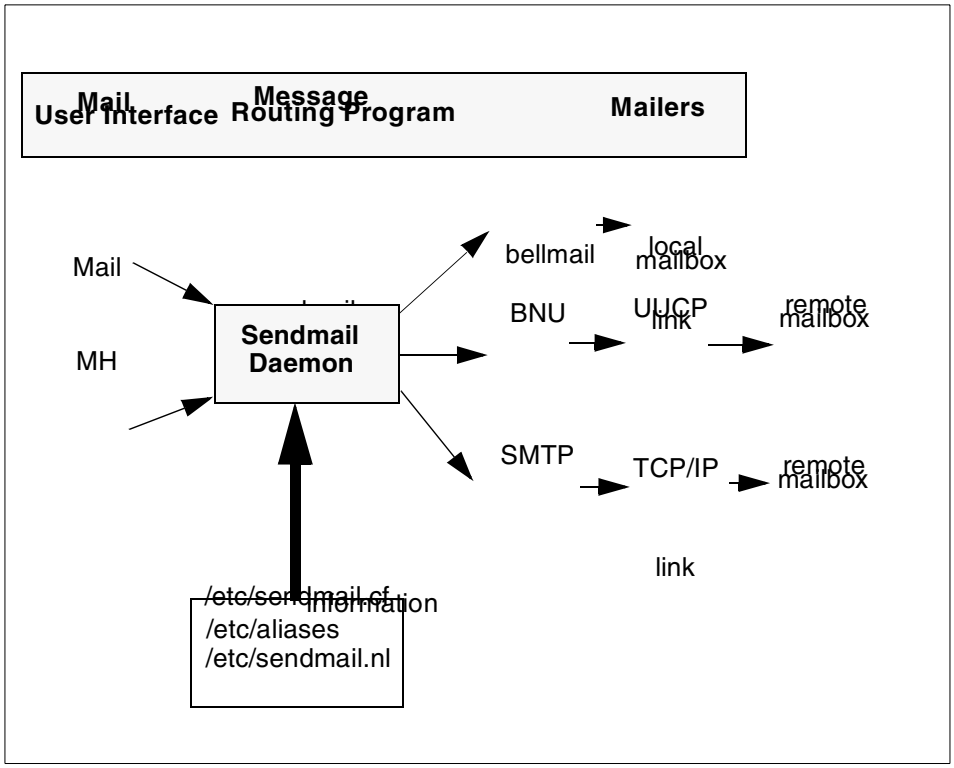

Figure 138. Overview of Mail System

To deliver local mail, the sendmail program routes messages to the bellmail program. The bellmail program delivers all local mail by appending messages to the user's system mailbox, which is in the /var/spool/mail directory.

To deliver mail over a UNIX-to-UNIX Copy Program (UUCP) link, the sendmail program routes messages using Basic Network Utilities (BNU).

To deliver Transmission Control Protocol/Internet Protocol (TCP/IP)-routed mail, the `sendmail` command establishes a TCP/IP connection to the remote system then uses Simple Mail Transfer Protocol (SMTP) to transfer the message to the remote system.

Figure 139 shows the mail management tasks for a system administrator.

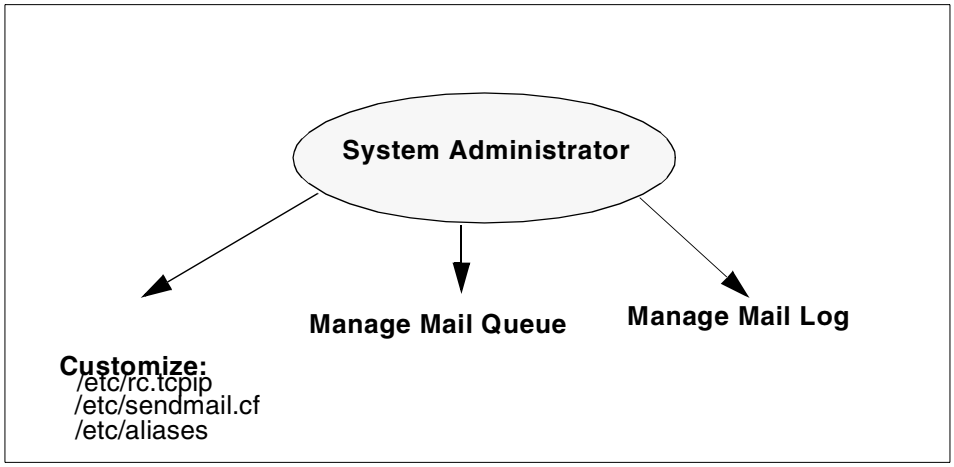

Figure 139. Mail Management Tasks

15.2 Mail Daemons

The following is a description of the mail daemons.

Sendmail daemon A message routing program routes messages to their destinations. The mail system's message routing program is the `sendmail` command, which is part of the Base Operating System (BOS) and is installed with BOS. The `sendmail` command is a daemon that uses information in the /etc/sendmail.cf file, the /etc/aliases file, and the /etc/sendmail.nl file to perform the necessary routing.

Syslogd daemon The `sendmail` command logs mail system activity through the syslogd daemon. The syslogd daemon must be configured and running for logging to occur. Refer section 15.4, “Mail Logs” on page 373 for more information about the syslogd daemon.

15.2.1 Starting the Sendmail Daemon

To start the sendmail daemon, enter either of the following commands:

```
startsrc -s sendmail
```

or

```
/usr/lib/sendmail
```

If the sendmail daemon is already active when you enter one of these previous commands, you will see the following message on the screen:

```
The sendmail subsystem is already active. Multiple instances are not
supported.
```

If the sendmail daemon is not already active, then a message indicating that the sendmail daemon has been started will be generated.

15.2.2 Stopping the Sendmail Daemon

To stop the sendmail daemon, execute the `stopsrc -s` command. If the sendmail daemon was not started with the `startsrc` command, find the sendmail PID and then kill the process issuing the following commands:

```
ps -ef |grep sendmail
kill -9 sendmail_pid
```

15.2.3 Refreshing the Sendmail Daemon

To refresh the sendmail daemon, issue the command:

```
refresh -s sendmail
```

15.2.4 Getting the Status of Sendmail Daemon

The following example shows how to get the status of sendmail daemon using `lssrc` command with -s flag. The status can be active or inoperative.

```
# lssrc -s sendmail
Subsystem         Group            PID     Status
 sendmail         mail             5422    active
```

15.2.5 Autostart of the Sendmail Daemon (/etc/rc.tcpip)

To configure the /etc/rc.tcpip file so that the sendmail daemon will be started at system boot time:

1. Edit the /etc/rc.tcpip file.
2. Find the line that begins with start /usr/lib/sendmail. By default, this line should be uncommented, that is, there is no # (pound sign) at the beginning of the line. However, if it is commented, delete the pound sign.

15.2.6 Specifying Time Values in Sendmail (in rc.tcpip)

The interval at which the sendmail daemon processes the mail queue is determined by the value of the -q flag when the daemon starts. The sendmail daemon is usually started by the /etc/rc.tcpip file at system startup. The

/etc/rc.tcpip file contains a variable called the queue processing interval (QPI) which it uses to specify the value of the -q flag when it starts the sendmail daemon. By default, the value of QPI is 30 minutes. To specify a different queue processing interval:

1. Edit the /etc/rc.tcpip file.
2. Find the line that assigns a value to the qpi variable, such as:

   qpi=30m
3. Change the value assigned to the qpi variable to the time value you prefer.

These changes will take effect at the next system restart. For the changes to take effect immediately, stop and restart the sendmail daemon specifying the new -q flag value.

15.2.7 Specifying Time Values in Sendmail (Not in rc.tcpip)

To set the message time-out and queue processing interval, you must use a specific format for the time value. The format of a time value is:

-qNumberUnit, where Number is an integer value and Unit is the unit letter. Unit may have one of the following values:

s Seconds

m Minutes

h Hours

d Days

w Weeks

If Unit is not specified, the sendmail daemon uses minutes (m) as the default. Here are three examples.

To process the queue every 15 days, issue the command:

```
/usr/sbin/sendmail -q15d
```

To process the queue every 15 hours, issue the command:

```
/usr/sbin/sendmail -q15h
```

To process the queue every 15 minutes, issue the command:

```
/usr/sbin/sendmail -q15
```

15.3 Mail Queue Directory: /var/spool/mqueue

The mail queue is a directory that stores data and controls files for mail messages that the `sendmail` command delivers. By default, the mail queue is /var/spool/mqueue. Mail messages may be queued for several reasons. First, the `sendmail` command can be configured to process the queue at certain intervals rather than immediately. If this is so, mail messages must be stored temporarily. Second, if a remote host does not answer a request for a mail connection, the mail system queues the message and tries again later.

15.3.1 Printing the Mail Queue

The contents of the queue can be printed using the `mailq` command (or by specifying the -bp flag with the `sendmail` command). This produces a listing of the queue IDs, the size of the message, the date the message entered the queue, and the sender and recipients.

15.3.2 Mail Queue Files

The mail queue directory /var/spool/mqueue contains four types of mail queue files:

Data file, Control file, Temporary file, Transcript file

Each message in the queue has a number of files associated with it. For example, if a message has a queue ID of AA00269, the following files are created and deleted in the mail queue directory while the `sendmail` command tries to deliver the message:

dfAA00269	Data file
qfAA00269	Control file
tfAA00269	Temporary file
xfAA00269	Transcript file

15.3.3 Forcing the Mail Queue to Run

In some cases, the mail queue becomes unresponsive. To force a queue to run, use the `sendmail` command with a -q flag (with no value). You can also use the -v flag (verbose) to watch what happens.

```
/usr/sbin/sendmail -q -v
```

15.3.4 Moving the Mail Queue

When a host goes down for an extended period, many messages routed to (or through) that host may be stored in your mail queue. As a result, the `sendmail` command spends a long time sorting the queue severely degrading your system's performance. If you move the queue to a temporary place and create a new queue, the old queue can be run later when the host returns to service. To move the queue to a temporary place and create a new queue:

1. Stop the sendmail daemon.
2. Move the entire queue directory by entering:

   ```
   cd /var/spool

   mv mqueue omqueue
   ```

3. Restart the sendmail daemon.
4. Process the old mail queue by entering:

   ```
   /usr/sbin/sendmail -oQ/var/spool/omqueue -q
   ```

   The -oQ flag specifies an alternate queue directory. The -q flag specifies to run every job in the queue. To get a report about the progress of the operation, use the -v flag. This operation can take a long time.

5. Remove the log files and the temporary directory when the queue is empty by entering:

   ```
   rm /var/spool/omqueue/*

   rmdir /var/spool/omqueue
   ```

15.4 Mail Logs

The `sendmail` command logs mail system activity through the syslogd daemon. The syslogd daemon must be configured and running for logging to occur. Specifically, the /etc/syslog.conf file may contain the uncommented line:

```
mail.debug              /var/spool/mqueue/log
```

If it does not, use an editor to make this change; be certain that the path name is correct. If you change the /etc/syslog.conf file while the syslogd daemon is running, refresh the syslogd daemon by entering the command:

```
refresh -s syslogd
```

If the /var/spool/mqueue/log file does not exist, you must create it by entering the command:

```
touch /var/spool/mqueue/log
```

15.4.1 Managing the Mail Log Files

Because information is continually appended to the end of the log file, it can become very large. Also, error conditions can cause unexpected entries to the mail queue. To keep the mail queue and log from growing too large, execute the /usr/lib/smdemon.cleanu shell script. This script forces the `sendmail` command to process the queue and maintains four progressively older copies of log files named log.0, log.1, log.2, and log.3. Each time the script runs it moves:

log.2 to log.3

log.1 to log.2

log.0 to log.1

log to log.0

This allows logging to start over with a new file. Run this script either manually or at a specified interval with the cron daemon. A typical log file is shown in Figure 140. The highlighted field, `stat=Deferred` refers to a message that could not get routed to the destination.

```
# pg /var/spool/mqueue/log
Nov  3 09:49:00 sv1051c sendmail[29038]: JAA29038: from user root: size is 43, c
lass is 0, priority is 30043, and nrcpts=1, message id is <199811031549.JAA29038
@sv1051c.itsc.austin.ibm.com>, relay=root@localhost
Nov  3 09:49:00 sv1051c sendmail[33716]: JAA29038: to=smith, ctladdr=root (0/0),
 delay=00:00:00, xdelay=00:00:00, mailer=local, stat=Sent
Nov  3 09:49:51 sv1051c sendmail[29042]: JAA29042: from user root: size is 57, c
lass is 0, priority is 30057, and nrcpts=1, message id is <199811031549.JAA29042
@sv1051c.itsc.austin.ibm.com>, relay=root@localhost
Nov  3 09:49:51 sv1051c sendmail[29330]: JAA29042: to=npsingh@in.ibm.com, ctladd
r=root (0/0), delay=00:00:00, xdelay=00:00:00, mailer=esmtp, relay=relay2.server
.ibm.com. [::ffff:9.14.2.99], stat=Deferred: Network is unreachable
#
```

Figure 140. /var/spool/mqueue/log File

15.4.2 Logging Mailer Statistics

The `sendmail` command tracks the volume of mail being handled by each of the mailer programs that interface with it (those mailers defined in the /etc/sendmail.cf file).

To start the accumulation of mailer statistics, create the /var/tmp/sendmail.st (refer to the sendmail.cf file for the exact path) file by entering:

```
touch /var/tmp/sendmail.st
```

The `sendmail` command updates the information in the file each time it processes mail. The size of the file does not grow, but the numbers in the file do. They represent the mail volume since the time you created or reset the /var/tmp/sendmail.st file.

15.4.3 Displaying Mailer Information

The statistics kept in the /var/tmp/sendmail.st file are in a database format that cannot be read as a text file. To display the mailer statistics, enter the command:

```
/usr/sbin/mailstats
```

This reads the information in the /etc/sendmail.st file, formats it, and writes it to standard output in the format shown in Figure 141.

```
# mailstats
Sendmail statistics from Tue Nov  3 11:43:27 CST 1998
 M msgsfr bytes_from  msgsto   bytes_to  Mailer
 3      3          3K      3          3K  local
 5      1          1K      1          1K  esmtp
=========================================
 T      4          4K      4          4K
# 
```

Figure 141. Displaying Mailer Information

The fields in the report have the following meanings:

msgs_from Contains the number of messages received by the local machine from the indicated mailer.

bytes_from Contains the number of bytes in the messages received by the local machine from the indicated mailer.

msgs_to Contains the number of messages sent from the local machine using the indicated mailer.

bytes_to Contains the number of bytes in the messages sent from the local machine using the indicated mailer.

15.5 Mail Aliasing

Aliases map names to address lists. The aliases are defined in /etc/aliases file by the user administrator. The /etc/aliases file consists of a series of entries in the following format:

Alias: Name1, Name2, ... NameX

where Alias can be any alphanumeric string that you choose (not including special characters, such as @ or !). Name1 through NameX is a series of one

or more recipient names. The /etc/aliases file must contain the following three aliases (a sample file is shown in Figure 142):

- MAILER-DAEMON
- postmaster
- nobody

```
# Licensed Materials - Property of IBM
#
# US Government Users Restricted Rights - Use, duplication or
# disclosure restricted by GSA ADP Schedule Contract with IBM Corp.
#
##
#  Aliases in this file will NOT be expanded in the header from
#  Mail, but WILL be visible over networks or from /bin/bellmail.
#
#       >>>>>>>>>>      The command "sendmail -bi" must be run after
#       >> NOTE >>      this file is updated for any changes to
#       >>>>>>>>>>      affect sendmail operation.
##

# Alias for mailer daemon
MAILER-DAEMON:root

# Following alias is required by the new mail protocol, RFC 822
postmaster:root

# Aliases to handle mail to msgs and news
nobody: /dev/null

# 
```

Figure 142. /etc/aliases File

15.5.1 Creating or Modifying Local System Aliases

To add the programer alias for four users (John, Smith, Mary, Bob) working together in the same department, perform the following functions:

1. Edit the /etc/aliases file.
2. On a blank line, add an alias followed by a colon (:) followed by a list of comma-separated recipients. For example, the following entry defines an alias named programer to be the names of the people in that group.

   ```
   programer: john, smith, mary@sv1051c, bob@sv1051c
   ```

3. Create an owner for any distribution list aliases. If the `sendmail` command has trouble sending mail to the distribution list, it sends an error message to the owner of that list. For example, the owner of the above list is root of system sv1051a and is defined by the following entry in /etc/aliases file:

   ```
   owner-sys: root@sv1051a
   ```

4. Recompile the /etc/aliases file as described in following section.

15.5.2 Building the Alias Database

The `sendmail` command does not directly use the alias definitions in the local system /etc/aliases file. Instead, the `sendmail` command reads a processed database manager (dbm) version of the /etc/aliases file. You can compile the alias database using one of the following methods:

Run the `/usr/sbin/sendmail` command using the -bi flag or run `newaliases`. This command causes the `sendmail` command to read the local system /etc/aliases file and creates two additional files containing the alias database information:

- /etc/aliases.dir
- /etc/aliases.pag

After you have completed building the alias database, you can use the alias (programer) to send mail to the users (smith and john) on the local system and the users (mary and bob) on system sv1051c by using `mail` command as shown below:

```
mail programer
```

15.6 Mail Addressing

Mail is sent to a user's address. How you address mail to an other user depends upon the user's location with respect to your system. How you address mail depends on whether you are sending the mail:

- To users on your local system.
- To users on your network.
- To users on a different network.
- Over a BNU or UUCP link.

15.6.1 To Address Mail to Users on Your Local System

To send a message to a user on your local system (to someone whose login name is listed in your /etc/passwd file), use the login name for the address. At your system command line prompt, you can use the `mail` command in the way shown in the following example:

```
mail LoginName
```

If smith is on your system and has the login name smith, use the command:

```
mail smith
```

15.6.2 To Address Mail to Users on Your Network

To send a message through a local network to a user on another system, at the command line enter:

```
mail LoginName@SystemName
```

For example, if john is on system sv1051c, use the following command to create and send a message to him:

```
mail john@sv1051c
```

15.6.3 To Address Mail to Users on a Different Network

If your network is connected to other networks, you can send mail to users on the other networks. The address parameters differ depending on how your network and the other networks address each other and how they are connected.

15.6.3.1 Using a Central Database of Names and Addresses:

Use the `mail` command in the way shown in the following example:

```
mail LoginName@SystemName
```

15.6.3.2 Using Domain Name Addressing

Use the `mail` command in the ways shown in the following examples:

```
mail LoginName@SystemName.DomainName
```

For example, to send mail to a user john, who resides in a remote network with a domain name in.ibm.com, use the following command:

```
mail john@in.ibm.com
```

15.6.4 To Address Mail over a BNU or UUCP Link

To send a message to a user on another system connected to your system by the Basic Networking Utilities (BNU) or another version of UNIX-to-UNIX Copy Program (UUCP), you must know the login name, the name of the other system, and the physical route to that other system.

When your computer has a BNU or UUCP link, at your system command line prompt you can use the command in the ways shown in the following examples.

```
mail UUCPRoute!LoginName
```

When the BNU or UUCP link is on another computer, use the `mail` command as shown below:

```
mail @InternetSystem:UUCPSystem!username
```

Notice that, in this format, you are not sending mail to a user at any of the intermediate systems; so, no login name precedes the `@` in the domain address.

15.7 Storing Mail

Mail is stored in different ways depending on specific situation as shown in Figure 143 on page 381. The mail program uses the following type of mailboxes or folders:

System Mailbox
This resides in /var/spool/mail directory and each system mailbox is named by the user ID associated with it. For example, if the user ID is smith, the system mailbox is /var/spool/mail/smith. When the mail arrives for any user ID, it is placed in the respective system mailbox. The shell checks for the new mail and issues the following message when the user logs in: `YOU HAVE NEW MAIL`

Personal Mailbox
Each user has a personal mailbox. When the mail is read using the `mail` command by the user, and if it is not saved in a file or deleted, it is written to user's personal mailbox, $HOME/mbox ($HOME is the default login directory). For a user ID smith, the personal mailbox is /home/smith/mbox.

dead.letter File
If the user interrupts the message being created to complete some other tasks, the system saves the incomplete message in the dead.letter file in the user's home directory ($HOME). For a user ID smith, /home/smith/dead.letter is the dead.letter file.

Folders
To save message in an organized fashion, users can use folders. Messages can be put into a user's personal folder from system mailbox or personal mailbox as shown in Figure 143 on page 381.

The `mail` command can be used with various flags as shown below:

`mail`	Displays the system mailbox.
`mail -f`	Displays your personal mailbox (mbox).

`mail -f+folder` Displays a mail folder.

`mail user@address` Addresses a message to the specified user.

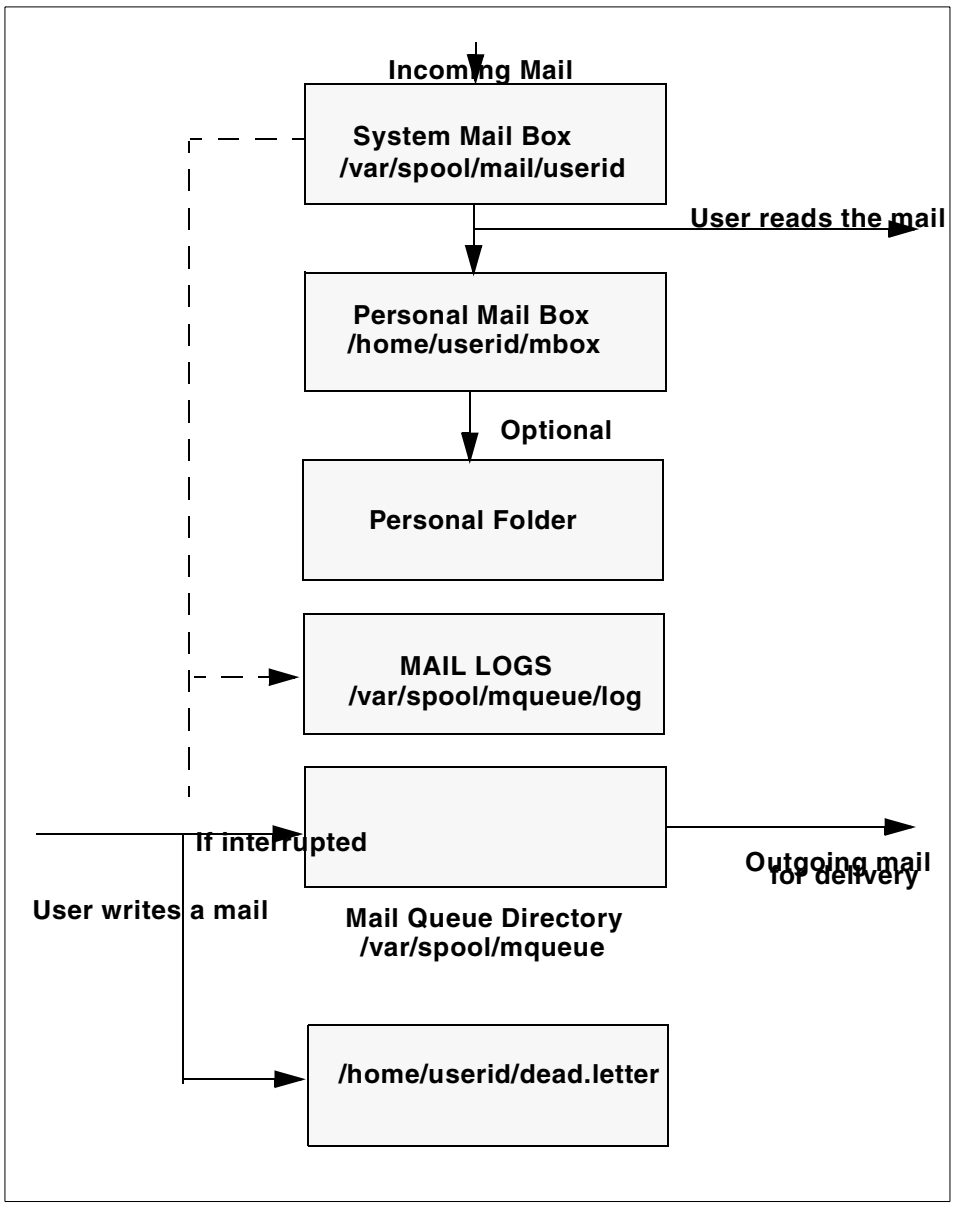

Figure 143. Message Path for Mail

15.8 Mail Administrator's Reference

This section provides a quick reference to the various mail commands, files, and directories.

15.8.1 List of Mail Commands

This list includes commands for using and managing the mail program.

`mailq`	Prints the contents of the mail queue.
`mailstats`	Displays statistics about mail traffic.
`newaliases`	Builds a new copy of the alias database from the /etc/aliases file.
`sendmail`	Routes mail for local or network delivery.
`smdemon.cleanu`	Cleans up the sendmail queue for periodic housekeeping.

15.8.2 List of Mail Files and Directories

This list of files and directories is arranged by function.

15.8.2.1 Using the Mail Program

$HOME/.mailrc	Enables the user to change the local system defaults for the mail program.
$HOME/mbox	Stores processed mail for the individual user.
/usr/bin/Mail, **/usr/bin/mail**, and **/usr/bin/mailx**	Specifies three names linked to the same program. The mail program is one of the user interfaces to the mail system.
/var/spool/mail	Specifies the default mail drop directory. By default, all mail is delivered to the /var/spool/mail/UserName file.
/var/spool/mqueue	Contains the log file and temporary files associated with the messages in the mail queue.

15.8.2.2 Using the Sendmail Command

/usr/sbin/sendmail	The `sendmail` command.

/usr/ucb/mailq	Links to the /usr/sbin/sendmail. Using `mailq` is equivalent to using the `/usr/sbin/sendmail -bp` command.
/usr/ucb/newaliases	Links to the /usr/sbin/sendmail file. Using `newaliases` is equivalent to using the `/usr/sbin/sendmail -bi` command.
/usr/sbin/mailstats	Formats and prints the sendmail statistics as found in the /etc/sendmail.st file, if it exists. The /etc/sendmail.st file is the default, but you can specify an alternative file.
/etc/aliases	Describes a text version of the aliases file for the `sendmail` command. You can edit this file to create, modify, or delete aliases for your system.
/etc/sendmail.cf	Contains the sendmail configuration information in text form. Edit the file to change this information.
/etc/sendmail.cfDB	Contains the processed version of the /etc/sendmail.cf configuration file. This file is created from the /etc/sendmail.cf file when you run the `/usr/sbin/sendmail -bz` command.
/etc/sendmail.nl	Contains the sendmail National Language Support (NLS) configuration information in text form. Edit the file to change this information.
/usr/lib/smdemon.cleanu	Specifies a shell file that runs the mail queue and maintains the sendmail log files in the /var/spool/mqueue directory.
/var/tmp/sendmail.st	Collects statistics about mail traffic. This file does not grow. Use the `/usr/sbin/mailstats` command to display the contents of this file.
/var/spool/mqueue	Describes a directory containing the temporary files associated with each message in the queue. The directory can contain the log file.

15.9 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. A Company would like to create an email alias on an AIX workstation that will forward email to a user on another workstation for collection of data. The system administrator would like to add this entry to the /etc/aliases file. Which of the following actions should be performed in order for the change to take affect?

   A. Reboot the workstation.

   B. Run the `mailq` command.

   C. Stop and start TCP/IP.

   D. Use the `sendmail` command.

2. A system administrator wants to process a mail queue after every 45 minutes. Which of the following commands should be used if the change must take effect immediately and be permanent?

   A. `sendmail -q45d`

   B. `sendmail -q45h` and also edit /etc/rc.tcpip to change qpi=45h

   C. `sendmail -q45` and also edit /etc/rc.tcpip to change qpi=45m

   D. `sendmail -q45`

3. All mail sent to root on system mars needs to be redirected to user admin on system earth. Prior to running the `newaliases` command, which command should be run in order to accomplish this goal?

   A. On system earth, run the command: `echo "mars: earth" >> /etc/hosts`

   B. On system mars, run the command: `echo "root:admin@earth" >> /etc/aliases`

   C. On system mars, run the command: `echo "root:admin@earth" >> /etc/sendmail.cf`

   D. On system earth, run the command: `echo "root:admin@earth" >> /etc/sendmail.cf`

15.9.1 Answers

The following are the answers to the previous questions:

1. D
2. C
3. B

15.10 Exercises

Provided here are some of the exercises you may wish to perform:

1. Display the status of the sendmail daemon on your system. If it is not active, start the sendmail daemon.
2. Locate the entry in /etc/rc.tcpip file, which starts the sendmail daemon at system boot time.
3. Customize the sendmail daemon to process the mail queue every 45 minutes. Make this change take effect immediately.
4. Create an alias for all the users in your department and compile the alias database. Compile the database?
5. Stop the sendmail daemon.

Chapter 16. Online Documentation

AIX 4.3 provides an optionally installable component for Web based documentation, the Documentation Search Service. It allows you to search online HTML documents. It provides a search form that appears in your Web browser. When you type words into the search form, it searches for the words and then presents a search results page that contains links that lead to the documents that contain the target words.

You can set up one of your AIX systems in your organization to be the documentation server and all other systems as documentation clients. This will allow documentation to be installed on only one system, and all other systems can access this system without needing the documentation installed locally.

You need the following products and components installed for a complete set of services.

- For the client:
  1. A Web browser
  2. The bos.docsearch.client.* filesets (for AIX integration)
- For the documentation server (which may also act as a client)
  1. The entire bos.docsearch package
  2. The documentation libraries
  3. A Web browser
  4. A Web server

The browser must be a forms-capable browser, and the Web server must be CGI-compliant.

If you are planning on integrating your own documentation on the documentation server, you will also need to build the document's indexes.

Except for the end-user tasks described in section 16.6, “Invoking Documentation Search Service” on page 392, you need root authority to perform the installation and configuration tasks

There are a variety of ways to install the documentation, Web server, and Document Search Service. You can use the Configuration Assistant TaskGuide, Web-Based Systems Management, or SMIT.

The easiest way for a non-technical user to install and configure Documentation Search Services is by using the Configuration Assistant TaskGuide. To run the Configuration Assistant TaskGuide, use the `configassist` command, then select the item titled Configure Online Documentation and Search.

If you would rather install Documentation Search Services manually, you can use SMIT.

16.1 Installing the Web Browser

Use `smit install_latest` to install Netscape supplied on the AIX 4.3 Bonus Pack CD. Use `smit list_installed` to check whether you have the following filesets installed as shown in Figure 144.

```
                                COMMAND STATUS

Command: OK            stdout: yes           stderr: no

Before command completion, additional instructions may appear below.

[TOP]
  Fileset                      Level  State  Description
  ---------------------------------------------------------------------------
  Netscape.msg.en_US.nav.rte
                             4.0.6.0    C    Netscape Navigator Runtime
                                             Messages - U.S. English
  Netscape.nav.rte           4.0.6.0    C    Netscape Navigator Runtime
                                             Environment


State Codes:
 A -- Applied.
 B -- Broken.
[MORE...4]

F1=Help             F2=Refresh          F3=Cancel           F6=Command
F8=Image            F9=Shell            F10=Exit            /=Find
n=Find Next
```

Figure 144. Netscape Filesets

If you are installing the Netscape browser from other sources, or you are installing other Web browsers, follow the installation instructions that come with the software. Note that there will not be any records in the ODM if your product source is not in installp format.

16.2 Installing the Web Server

You may install any CGI-compliant Web Server. The Lotus Domino Go Webserver is used here. It is supplied on one of the AIX 4.3 Bonus Pack CDs.

The Documentation Search Service uses its own search engine CGIs. Therefore, you do not need to install the NetQ fileset, the Webserver Search Engine. The following shows the filesets installed (Figure 145).

```
                                COMMAND STATUS

Command: OK            stdout: yes           stderr: no

Before command completion, additional instructions may appear below.

[TOP]
  Fileset                      Level  State  Description
  ----------------------------------------------------------------------------
  internet_server.base.admin
                             4.6.2.5    C    Lotus Domino Go Webserver
                                             Administration
  internet_server.base.doc   4.6.2.5    C    Lotus Domino Go Webserver
                                             Documentation
  internet_server.base.httpd
                             4.6.2.5    C    Lotus Domino Go Webserver
  internet_server.msg.en_US.httpd
                             4.6.2.5    C    Lotus Domino Go Webserver
                                             Messages - en_US
[MORE...9]

F1=Help             F2=Refresh          F3=Cancel           F6=Command
F8=Image            F9=Shell            F10=Exit            /=Find
n=Find Next
```

Figure 145. Domino Go Webserver Filesets

If you are installing the Domino Go Webserver from other sources, or you are installing another Web server, follow the installation instructions that come with the software. Note that there will not be any records in the ODM if your product source is not in installp format.

16.3 Installing Documentation Search Service

The Documentation Search Service is (at the time of writing) on Volume 2 of the AIX 4.3 installation CDs. Install the client portions for a client AIX image or install the entire bos.docsearch package for a documentation server. The following filesets are the prerequisite for other Documentation Search Service filesets (such as IMNSearch).

- bos.docsearch.client.Dt

- bos.docsearch.client.com
- bos.docsearch.rte

For the documentation clients, you need only a Web browser. Installation of the bos.docsearch.client fileset will give you the CDE desktop icon and the `docsearch` command. Refer to 16.6, “Invoking Documentation Search Service” on page 392 for further details.

Use `smit list_installed` to check whether you have the following filesets installed, as shown in Figure 146.

```
                                COMMAND STATUS

Command: OK            stdout: yes           stderr: no

Before command completion, additional instructions may appear below.

[MORE...1]
  ---------------------------------------------------------------------------
  IMNSearch.bld.DBCS         1.2.0.4    C    NetQuestion DBCS Buildtime
                                             Modules
  IMNSearch.bld.SBCS         1.2.1.3    C    NetQuestion SBCS Buildtime
                                             Modules
  IMNSearch.rte.DBCS         1.2.0.4    C    NetQuestion DBCS Search Engine
  IMNSearch.rte.SBCS         1.2.1.3    C    NetQuestion SBCS Search Engine
  IMNSearch.rte.httpdlite    1.1.1.1    C    NetQuestion Local HTTP Daemon
  bos.docsearch.client.Dt    4.3.2.0    C    DocSearch Client CDE Application
                                             Integration
  bos.docsearch.client.com   4.3.2.0    C    DocSearch Client Common Files
  bos.docsearch.rte          4.3.2.0    C    DocSearch Runtime
[MORE...9]

F1=Help             F2=Refresh          F3=Cancel           F6=Command
F8=Image            F9=Shell            F10=Exit            /=Find
n=Find Next
```

Figure 146. Documentation Search Service Filesets

16.4 Configuring Documentation Search Service

Use either `wsm` or `smit` to configure the documentation search service. If you used the Configuration Assistant TaskGuide to install and configure the Documentation Search Service, you will not need to perform any further configuration.

For `wsm`, double-click on the **Internet Environment** icon, or you can use `smit web_configure` to configure the following:

- Default browser

Type into the field the command that launches the browser that you want to be the default browser for all users on this computer, for example, `/usr/prod/bin/netscape`. This will set the /etc/environment variable DEFAULT_BROWSER to the string you type in.

- Documentation and search server

  You can define the documentation search server location to be:

  - None - disabled
  - Remote computer

    Type the remote documentation server name. The default TCP/IP port address is 80. Change it to the port address used by the documentation server.

  - Local - this computer

    If you are using Lotus Domino Go Webserver or IBM Internet Connection Server in the default location, all the default settings of the cgi-bin directory and HTML directory will have been filled in for you. If you are using other Web servers, or you are not using the default location, you have to fill in your cgi-bin directory and HTML directory that the Web server requires. You may change the port address used by the server. If you change the port address, you have to use the same address for all your documentation clients.

16.5 Installing Online Manuals

You can either install the documentation information onto the hard disk or mount the documentation CD in the CD-ROM drive. Mounting the CD will save some amount of hard disk space, but it requires the CD to be kept in the CD-ROM drive at all times. Also, searching the documentation from the CD-ROM drive can be significantly slower (in some cases up to 10 times slower) than searching the information if it is installed on a hard disk. In addition, there are two documentation CDs:

- The AIX Version 4.3 Base Documentation CD
- The AIX Version 4.3 Extended Documentation CD

Use `smit install_latest` to install the online manuals onto the hard disk. The fileset bos.docregister is a prerequisite for all online manuals. It will be automatically installed the first time you install any online manuals even if you have not selected this fileset.

Note

The installation images located on the AIX Version 4.3 Base Documentation and Extended Documentation CDs do not contain the HTML files. These files exist separately on the CD to allow access from non-AIX platforms. Installing the images from the CD will work correctly; however, copying the installation images by themselves to another location is not enough for a proper install

16.6 Invoking Documentation Search Service

You must log out and log in again after the Documentation Search Service has been configured so that you will pick up the environment variables set up during the configuration.

If you are running the CDE desktop environment, double-click the **Documentation Search Service** icon in the Application Manager window.

Alternatively, you can use the command `docsearch` to invoke the documentation search service. Your Web browser will start, and you should see the Documentation Search Service page. Netscape is used as the default Web browser for this discussion.

You can invoke the Documentation Search Service without installing the docsearch client component. In fact, you do not even need to invoke the documentation search service from an AIX machine. You can do this by first invoking the browser and entering the following URL:

`http://<server_name>[:<port_number>]/cgi-bin/ds_form`

This URL points to a global search form on the document server where the name of the remote server is given in `server_name`. The `port_number` only needs to be entered if the port is different from 80.

If you have not run Netscape previously, a series of informational messages and windows will be shown while Netscape is setting up the environment in your home directory. This is standard behavior for the first execution of Netscape. The messages will not be shown again the next time you start Netscape.

The top part of the Documentation Search Service page allows you to specify your search criteria, and the bottom part shows what online manuals have been installed. The following shows the documentation search service page

with only the command reference manuals and the programming guide manuals installed (Figure 147).

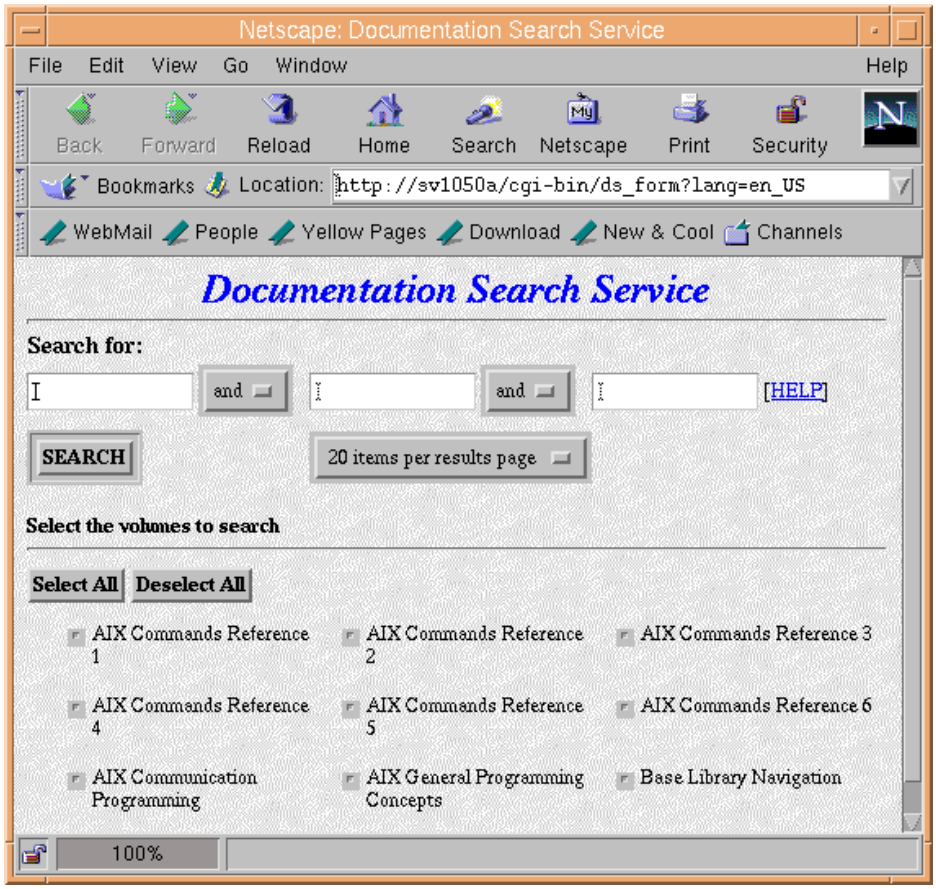

Figure 147. Documentation Search Service

If you have a problem starting the Documentation Search Service, check the following environment variables. These environment variables may be set, displayed, and changed using SMIT. Start SMIT, select **System Environments**, then select **Internet and Documentation Services**.

- On the client machine
  1. Invoke the Web browser manually and enter the URL `http://<server_name>[:<port_number>]/cgi-bin/ds_form` to ensure that the server is up and running.

2. Ensure the DEFAULT_BROWSER variable is set to the command for starting your Web browser.

   Use the command `echo $DEFAULT_BROWSER` to find out the command used in starting the browser. Test whether that command can bring up the browser by manually entering it on the command line.

3. Ensure the DOCUMENT_SERVER_MACHINE_NAME variable is set to the document server's hostname or IP address.
4. Ensure the DOCUMENT_SERVER_PORT variable is set to the port address used by the document server's port address.

- On the server machine

1. Ensure the DEFAULT_BROWSER variable is set to the command for starting your Web browser.

   Use the command `echo $DEFAULT_BROWSER` to find out the command used in starting the browser. Test whether that command can bring up the browser by manually entering it on the command line.

2. Ensure the DOCUMENT_SERVER_MACHINE_NAME variable is set to the local hostname.
3. Ensure the DOCUMENT_SERVER_PORT variable is set to the port address used by the local Web server.
4. Ensure that the CGI_DIRECTORY variable is set to the correct cgi-bin directory used by the local Web server.
5. Ensure that the DOCUMENT_DIRECTORY is set to the directory where the symbolic links `doc_link` and `ds_images` reside. If you have not changed the default, it should be in /usr/lpp/internet/server_root/pub for both IBM Internet Connection Server and Lotus Domino Go Web Server.
6. If you are not using the default directory, ensure that you have defined the necessary directory mapping in your Web server configuration file so that the directory can be resolved.

16.7 Quiz

The following questions are designed to help you verify your knowledge of this chapter:

1. By installing the Documentation Search Services client fileset, the following will be made available to your AIX Version 4.3 system:

   A. CDE icon

B. Web browser

C. `docsearch` command and CDE icon

D. `info` command and CDE icon

2. From a forms-capable Web browser, the URL used to access the online documentation server on an AIX Version 4.3 system is:

   A. `http://<server_name>[:<port_number>]/cgi-bin/ds_form`

   B. `http://<server_name>[:<port_number>]/cgi-bin/docsearch`

   C. `http://<server_name>[:<port_number>]/cgi-bin/info`

   D. `http://<server_name>[:<port_number>]/cgi-bin/man`

16.7.1 Answers

The following are the answers to the previous questions:

1. C
2. A

16.8 Exercise

Provided here are some exercises you may wish to perform:

1. Install a Web browser.
2. Install a Web server.
3. Install the Document Search Services fileset.
4. Install some online manuals.
5. Configure Document Search Services
6. Access the online manuals using the `docsearch` command and from a Web browser on other systems.

Chapter 17. The AIX Windows Font Server

XFS is the AIXwindows font server subsystem (prior to AIX Version 4.3, it was named fs) that supplies fonts to AIXwindows display servers. In the following sections, topics related to administration of the font server are discussed.

17.1 XFS Server Interrupts

The xfs server responds to the following signals:

SIGTERM Causes the font server to exit cleanly.

SIGUSR1 Causes the server to re-read its configuration file.

SIGUSR2 Causes the server to flush any cached data it may have.

SIGHUP Causes the server to reset, closing all active connections and re-reads the configuration file.

The server is usually run by a system administrator and started by way of boot files, such as /etc/rc.tcpip. Users may also wish to start private font servers for specific sets of fonts.

The configuration language is a list of keyword and value pairs. Each keyword is followed by an = (equal sign) and the desired value.

17.2 XFS Keywords

The following list shows recognized keywords and the types and descriptions of valid values.

#	A comment character when located in the first column.
catalogue (List of string)	Ordered list of font path element names. The current implementation only supports a single catalogue ("all") containing all of the specified fonts.
alternate-servers (List of string)	List of alternate servers for this font server.
client-limit (Cardinal)	Number of clients that this font server will support before refusing service. This is useful for tuning the load on each individual font server.

clone-self (Boolean)	Whether this font server should attempt to clone itself when it reaches the client limit.
default-point-size (Cardinal)	The default point size (in decipoints) for fonts that do not specify.
default-resolutions (Series)	Resolutions the server supports by default. This information may be used as a hint for pre-rendering and substituted for scaled fonts that do not specify a resolution. A resolution is a comma-separated pair of x and y resolutions in pixels per inch. Multiple resolutions are separated by commas.
error-file (String)	File name of the error file. All warnings and errors are logged here.
port (Cardinal)	TCP port on which the server will listen for connections. The default is 7100.
use-syslog (Boolean)	Whether the syslog function (on supported systems) is to be used for errors.
deferglyphs (String)	Sets the mode for delayed fetching and caching of glyphs. Value is none, meaning deferred glyphs is disabled. All, meaning deferred glyphs is enabled for all fonts, and 16 , meaning deferred glyphs is enabled only for 16-bit fonts.

17.3 XFS Form Conventions

One of the following forms can be used to name a font server that accepts TCP connections.

```
tcp/hostname:port
tcp/hostname:port/cataloguelist
```

The `hostname` specifies the name (or decimal numeric address) of the machine on which the font server is running. The `port` is the decimal TCP port on which the font server is listening for connections. The `cataloguelist` specifies a list of catalogue names with '+' as a separator. The following are some examples:

```
tcp/expo.lcs.mit.edu:7100, tcp/18.30.0.212:7101/all
```

One of the following forms can be used to name a font server that accepts DECnet connections.

```
decnet/nodename::font$objname
decnet/nodename::font$objname/cataloguelist
```

The `nodename` specifies the name (or decimal numeric address) of the machine on which the font server is running. The `objname` is a normal, case-insensitive DECnet object name. The `cataloguelist` specifies a list of catalogue names with '+' as a separator.

17.4 XFS Command Flags

Table 44 displays the flags used by the `xfs` command.

Table 44. Flags for the xfs Command

Flag	Description
-cf *ConfigurationFile*	Specifies the configuration file the font server will use.
-ls *ListenSocket*	Specifies a file descriptor that is already set up to be used as the listen socket. This option is only intended to be used by the font server itself when automatically spawning another copy of itself to handle additional connections.
-port *Number*	Specifies the TCP port number on which the server will listen for connections.

17.5 Font Server Examples

The following is a sample of the /usr/lib/X11/fs/config file. Any changes made to the font server are done in this file.

```
# SCCSID_BEGIN_TAG
# @(#)99  1.2  src/gos/2d/XTOP/programs/xfs/config.cpp, xfontserver,
gos43D, 981
1A_43D 3/10/98 16:02:38
# SCCSID_END_TAG
# font server configuration file
# $XConsortium: config.cpp,v 1.7 91/08/22 11:39:59 rws Exp $

clone-self = on
use-syslog = off
catalogue = /usr/lib/X11/fonts/,/usr/lib/X11/fonts/misc/,/usr/lib/X11/f
onts/75dpi/,/usr/lib/X11/fonts/100dpi/,/usr/lib/X11/fonts/i18n/,/usr/li
```

```
b/X11/fonts/ibm850/,/usr/lib/X11/fonts/TrueType/,/usr/lib/X11/fonts/Typ
e1/
error-file = /usr/lib/X11/fs/fs-errors
# in decipoints
default-point-size = 120
default-resolutions = 75,75,100,100

# The fontserver will default to using port 7100 if not overridden.
# Historically in AIX (4.1 and 4.2) 7500 is used and specified here.
# To restore this default, simply uncomment the following line.
# port = 7500
```

Once you have made your changes to the /usr/lib/X11/fs/config file you then run the following:

```
xfsconf
```

When this script is run, you can start the fontserver sub process by entering the following:

```
startsrc -s xfs
0513-059 The xfs Subsystem has been started. Subsystem PID is 19746.
```

In this case, the system has given the font server subsystem a PID of 19746.

17.6 Quiz

In this section, you are quizzed on your knowledge of the font server and starting the subsystem.

1. A system administrator uses the `startsrc` command to start the font server and gets the following message:

   ```
   "subsystem not on file"
   ```

   Which of the following is the proper way to make this subsystem available?

   A. Run the xfsconf script, then run the `startsrc -s xfs` command.

   B. Run the `startsrc -s xfs` command and then the `refresh -s inetd` command.

   C. The font server cannot be controlled by the system resource controller.

   D. Run the `definesrc -s xfs` command.

17.6.1 Answers

The following are the answers to the previous questions:

1. A

17.7 Exercises

Provided here are some exercises you may wish to perform:

Configure and start the font server.

Appendix A. Special Notices

This publication is intended to help IBM Business Partners, technical professionals, and customers of IBM prepare for the AIX V4.3 System Administration exam as part of the IBM Certified Specialist program. The information in this publication is not intended as the specification of any programming interfaces that are provided by AIX Version 4.3. See the PUBLICATIONS section of the IBM Programming Announcement for AIX Version 4.3 for more information about what publications are considered to be product documentation. The use of this guide for certification is not a promise of passing the exam or obtaining the certification. It is intended to be used as a supplemental learning tool that, when used in combination with professional instructors, accelerates the learning process.

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Appendix B. Related Publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this redbook.

B.1 International Technical Support Organization Publications

For information on ordering these ITSO publications see “How to Get ITSO Redbooks” on page 409.

- *Communication Solutions Guide for RS/6000 and AIX V4*, SG24-4899
- *Understanding IBM RS/6000 Performance and Sizing*, SG24-4810
- *AIX Version 4.3 Differences Guide*, SG24-2014
- *AIX Version 4.3 Migration Guide*, SG24-5116
- *AIX Storage Management*, GG24-4484
- *The Basics of IP Network Design*, SG24-2580
- *A Technical Introduction to PCI-based RS/6000 Servers*, SG24-4690
- *Monitoring and Managing IBM SSA Disk Subsystems*, SG24-5251
- *IBM Certification Study Guide: AIX V4.3 System Support*, SG24-5139
- *IBM Certification Study Guide: AIX HACMP*, SG24-5131 (Available June 1999)
- *IBM Certification Study Guide: RS/6000 SP*, SG24-5348

B.2 Redbooks on CD-ROMs

Redbooks are also available on the following CD-ROMs:

CD-ROM Title	Collection Kit Number
System/390 Redbooks Collection	SK2T-2177
Networking and Systems Management Redbooks Collection	SK2T-6022
Transaction Processing and Data Management Redbook	SK2T-8038
Lotus Redbooks Collection	SK2T-8039
Tivoli Redbooks Collection	SK2T-8044
AS/400 Redbooks Collection	SK2T-2849
RS/6000 Redbooks Collection (HTML, BkMgr)	SK2T-8040
RS/6000 Redbooks Collection (PostScript)	SK2T-8041
RS/6000 Redbooks Collection (PDF Format)	SK2T-8043
Application Development Redbooks Collection	SK2T-8037

B.3 Other Publications

These publications are also relevant as further information sources:

- *AIX Version 4.3 Installation Guide*, SC23-4112
- *AIX Version 4.3 Commands Reference, Volume 1*, SC23-4115
- *AIX Version 4.3 Commands Reference, Volume 3*, SC23-4117
- *AIX Version 4.3 Commands Reference, Volume 4*, SC23-4118
- *AIX Version 4.3 System Management Guide: Operating System and Devices*, SC23-4126
- *AIX Versions 3.2 and 4 Asynchronous Communications Guide*, SC23-2488
- *AIX Version 4.3 Messages Guide and Reference*, SC23-4129
- *AIX Version Problem Solving Guide and Reference*, SC23-4123
- *AIX Version 4.3 Kernel Extensions and Device Support Programming Concepts*, SC23-4125
- *AIX Version 3.2 & 4 Performance Tuning Guide*, SC23-2365
- *AIX Version 4.3 Guide to Printers and Printing*, SC23-4130

B.3.1 Limited Internet Resources

- *URL:* `http://service.software.ibm.com/support`
- *URL:* `http://www.developer.ibm.com`
- *URL:* `http://service.software.ibm.com/rs6k/techdocs`
- *URL:* `http://www.ibm.com/education/certify`

How to Get ITSO Redbooks

This section explains how both customers and IBM employees can find out about ITSO redbooks, redpieces, and CD-ROMs. A form for ordering books and CD-ROMs by fax or e-mail is also provided.

- **Redbooks Web Site** http://www.redbooks.ibm.com/

  Search for, view, download or order hardcopy/CD-ROM redbooks from the redbooks web site. Also read redpieces and download additional materials (code samples or diskette/CD-ROM images) from this redbooks site.

  Redpieces are redbooks in progress; not all redbooks become redpieces and sometimes just a few chapters will be published this way. The intent is to get the information out much quicker than the formal publishing process allows.

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- **Fax Orders**

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This information was current at the time of publication, but is continually subject to change. The latest information for customer may be found at http://www.redbooks.ibm.com/ and for IBM employees at http://w3.itso.ibm.com/.

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List of Abbreviations

ABI	Application Binary Interface
AC	Alternating Current
ADSM	ADSTAR Distributed Storage Manager
ADSTAR	Advanced Storage and Retrieval
AIX	Advanced Interactive Executive
ANSI	American National Standards Institute
APAR	Authorized Program Analysis Report
ASCI	Accelerated Strategic Computing Initiative
ASCII	American National Standards Code for Information Interchange
ATM	Asynchronous Transfer Mode
BFF	Backup File Format
BOS	Base Operating System
BI	Business Intelligence
BIST	Built-In Self-Test
BLAS	Basic Linear Algebra Subprograms
BOS	Base Operating System
CAE	Computer-Aided Engineering
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacturing
CATIA	Computer-Graphics Aided Three-Dimensional Interactive Application
CD	Compact Disk
CD-ROM	Compact Disk-Read Only Memory
CE	Customer Engineer
CEC	Central Electronics Complex
CHRP	Common Hardware Reference Platform
CLIO/S	Client Input/Output Sockets
CMOS	Complimentary Metal Oxide Semiconductor
COLD	Computer Output to Laser Disk
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CSR	Customer Service Representative
CSS	Communication Subsystems Support
CSU	Customer Set-Up
CSU	Channel Service Unit
CWS	Control Workstation
DAS	Dual Attach Station
DASD	Direct Access Storage Device (Disk)
DAT	Digital Audio Tape
DC	Direct Current
DDC	Display Data Channel
DDS	Digital Data Storage
DE	Dual-Ended
DFS	Distributed File System

DIMM Dual In-Line Memory Module

DIP Direct Insertion Probe

DIVA Digital Inquiry Voice Answer

DLT Digital Linear Tape

DMA Direct Memory Access

DOS Disk Operating System

DRAM Dynamic Random Access Memory

DSU Data Service Unit

DW Data Warehouse

EC Engineering Change

ECC Error Checking and Correction

EEPROM Electrically Erasable Programmable Read Only Memory

EIA Electronics Industry Association

EISA Extended Industry Standard Architecture

ELA Error Log Analysis

EMIF ESCON Multiple Image Facility

EPOW Environmental and Power Warning

ESCON Enterprise Systems Connection (Architecture, IBM System/390)

ESSL Engineering and Scientific Subroutine Library

ETML Extract, Transformation, Movement and Loading

F/C Feature Code

FC-AL Fibre Channel-Arbitrated Loop

FCP Fibre Channel Protocol

FDDI Fiber Distributed Data Interface

FDX Full Duplex

FRU Field Replaceable Unit

FTP File Transfer Protocol

F/W Fast and Wide

GPFS General Parallel File System

GUI Graphical User Interface

HACMP High Availability Cluster Multi Processing

HACWS High Availability Control Workstation

HDX Half Duplex

HIPPI High Performance Parallel Interface

HiPS High Performance Switch

HiPS LC-8 Low-Cost Eight-Port High Performance Switch

HP Hewlett-Packard

HPF High Performance FORTRAN

HPSSDL High Performance Supercomputer Systems Development Laboratory

HP-UX Hewlett-Packard UNIX

HTTP Hypertext Transfer Protocol

Hz Hertz

IA Intel Architecture

ID Identification

IDE Integrated Device Electronics

IDS Intelligent Decision Server

IEEE Institute of Electrical and Electronics Engineers

I^2C Inter Integrated-Circuit Communications

I/O Input/Output

IP Internetwork Protocol (OSI)

IPL Initial Program Load

IrDA Infrared Data Association (which sets standards for infrared support including protocols for data interchange)

IRQ Interrupt Request

ISA Industry Standard Architecture

ISB Intermediate Switch Board

ISDN Integrated-Services Digital Network

ISV Independent Software Vendor

ITSO International Technical Support Organization

JBOD Just a Bunch of Disks

JFS Journaled File System

JTAG Joint Test Action Group

L1 Level 1

L2 Level 2

LAN Local Area Network

LANE Local Area Network Emulation

LAPI Low-Level Application Programming Interface

LED Light Emitting Diode

LFT Low Function Terminal

LP Linear Programming

LPP Licensed Program Product

LVM Logical Volume Manager

MAP Maintenance Analysis Procedure

MAU Multiple Access Unit

Mbps Megabits Per Second

MBps Megabytes Per Second

MCA Micro Channel Architecture

MCAD Mechanical Computer-Aided Design

MES Miscellaneous Equipment Specification

MIP Mixed-Integer Programming

MLR1 Multi-Channel Linear Recording 1

MMF Multi-Mode Fibre

MP Multiprocessor

MP Multi-Purpose

MPC-3 Multimedia PC-3

MPI Message Passing Interface

MPP Massively Parallel Processing

MPS Mathematical Programming System

MTU Maximum Transmission Unit

MVS Multiple Virtual Storage (IBM System 370 and 390)

MX Mezzanine Bus

NCP Network Control Point

NFS Network File System

NIM Network Installation Manager

NT-1 Network Terminator-1

NTP Network Time Protocol

NUMA Non-Uniform Memory Access

NVRAM Non-Volatile Random Access Memory

OCS Online Customer Support

ODM Object Data Manager

OLAP Online Analytical Processing

OS/390 Operating System/390

OSL Optimization Subroutine Library

OSLp Parallel Optimization Subroutine Library

P2SC Power2 Super Chip

PAP Privileged Access Password

PBLAS Parallel Basic Linear Algebra Subprograms

PCI Peripheral Component Interconnect

PDU Power Distribution Unit

PE Parallel Environment

PEDB Parallel Environment Debugging

PID Program Identification

PIOFS Parallel Input Output File System

POE Parallel Operating Environment

POP Power-On Password

POSIX Portable Operating Interface for Computing Environments

POST Power-On Self-test

POWER Performance Optimization with Enhanced Risc (Architecture)

PPP Point-to-Point Protocol

PREP PowerPC Reference Platform

PSSP Parallel System Support Program

PTF Program Temporary Fix

PTPE Performance Toolbox Parallel Extensions

PTX Performance Toolbox

PV Physical Volume

PVC Permanent Virtual Circuit

QMF Query Management Facility

QP Quadratic Programming

RAM Random Access Memory

RAN Remote Asynchronous Node

RAS Reliability, Availability, and Serviceability

RAID Redundant Array of Independent Disks

RDBMS Relational Database Management System

RIPL Remote Initial Program Load

ROLTP	Relative Online Transaction Processing
RPA	RS/6000 Platform Architecture
RVSD	Recoverable Virtual Shared Disk
RTC	Real-Time Clock
SAN	Storage Area Network
SAS	Single Attach Station
SAR	Solutions Assurance Review
ScaLAPACK	Scalable Linear Algebra Package
SCO	Santa Cruz Operations
SCSI	Small Computer System Interface
SDR	System Data Repository
SDRAM	Synchronous Dynamic Random Access Memory
SDLC	Synchronous Data Link Control
SE	Single-Ended
SEPBU	Scalable Electrical Power Base Unit
SGI	Silicon Graphics Incorporated
SLIP	Serial Line Internet Protocol
SLR1	Single-Channel Linear Recording 1
SMIT	System Management Interface Tool
SMS	System Management Services
SMP	Symmetric Multiprocessing
SOI	Silicon-on-Insulator
SP	Scalable POWERParallel
SP	Service Processor
SPEC	Standard Performance Evaluation Corp.
SPOT	Shared Product Object Tree
SPS	SP Switch
SPS-8	Eight-Port SP Switch
SRC	System Resource Controller
SSC	System Support Controller
SSA	Serial Storage Architecture
STP	Shielded Twisted Pair
SUP	Software Update Protocol
SVC	Switch Virtual Circuit
Tcl	Tool Command Language
TCP/IP	Transmission Control Protocol/Internet Protocol
TCQ	Tagged Command Queuing
TPC	Transaction Processing Council
UDB EEE	Universal Database and Enterprise Extended Edition
UP	Uniprocessor
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
UUCP	UNIX-to-UNIX Communication Protocol

VESA	Video Electronics Standards Association
VG	Volume Group
VM	Virtual Machine (IBM System 370 and 390)
VMM	Virtual Memory Manager
VPD	Vital Product Data
VSD	Virtual Shared Disk
VSM	Visual Systems Management
VSS	Versatile Storage Server
VT	Visualization Tool
WAN	Wide Area Network
WTE	Web Traffic Express
XTF	Extended Distance Feature

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